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The Limit of Visibility of Penumbral Lunar Eclipses

By ALEXANDER POGO

Reports concerning the observation of the penumbral lunar eclipse of 1937 May 25 have reached me from numerous points located in the Eastern Standard Time zone and from several points in the Central Standard Time zone, from the Gulf of Mexico to Canada; reports concerning clouds and rain were kindly sent to me from points where "unusual" weather conditions made it impossible to take advantage of the high altitude of the moon and of the reasonably early hour of the eclipse. I hereby express my thanks to those who observed or tried to observe the penumbral lunar eclipse of 1937 May 25.

The majority of the observers reported that they could not notice a darkening of the northern limb of the moon; this group of observers did not include a single professional astronomer. On the other hand, professional astronomers in Massachusetts, Ohio, Tennessee, and Florida, and several non-professional observers in various parts of the country, gave good descriptions of the appulse, with estimates of the obscured fraction of the moon's diameter. Whenever a naked-eye phenomenon is observed near the limit of its visibility, a similar disagreement of the observers is to be expected; the cases of a sixth-magnitude star, of a close naked-eye binary, or of a variable star of small amplitude could be quoted; eyesight, color-sensitivity, training, etc., account for the divergence of opinion—a phenomenon quite invisible to one observer may be clearly visible to another. The penumbral lunar eclipse of 1937 May 25 may, therefore, be considered as a phenomenon observed near the limit of its naked-eye visibility.

The estimated duration of certain—as opposed to suspected—visibility of the appulse of 1937 May 25 varied considerably from report to report; one quarter of an hour seems to be an acceptable average. The obscured fraction of the lunar diameter was estimated by the various observers as $\frac{1}{5}$, $\frac{1}{4}$, or $\frac{1}{3}$. The color of the obscured northern limb was characterized as gray or as neutral.

The penumbral eclipse of 1937 May 25 occurred while the moon was near apogee; the apparent diameter of the moon was $29'.5$; the negative magnitude of the eclipse, computed by two entirely different methods, was found to be -0.30; the computed approach of the eclipsed limb to the physical umbra was $8'.8$. Observational evidence indicates, therefore, that a distance of $9'$ between the limb of the moon and the physical

umbra may be considered as a criterion of the limit of visibility, to the naked eye, of penumbral lunar eclipses. Table I shows that, for eclipses occurring at perigee, a distance of 9′ corresponds to a negative magni-

TABLE I

LIMITING MAGNITUDES OF LUNAR APPULSES AND DISTANCES OF THE LIMB FROM THE PHYSICAL UMBRA

Magnitude	Distance at Perigee	Distance at Apogee
—0.27	9′.0	7′.9
—0.28	9.4	8.2
—0.29	9.7	8.5
—0.30	10.1	8.8
—0.31	10.4	9.1
—0.32	10.7	9.4
—0.33	11.1	9.7
—0.34	11.4	10.0

tude of —0.27. Observers who had no difficulty in noticing the darkening of the northern limb during the eclipse of 1937 May 25 would, in all probability, be able to observe a lunar appulse, at apogee, even if the corresponding negative magnitude were comprised between —0.30 and —0.33 or —0.34; it ought to be remembered that a faint darkening is more likely to be noticed if the white southern limb of the moon, instead of the dark northern one, happens to pass within 9′ or 10′ of the physical umbra.

The limit of visibility of penumbral lunar eclipses has a practical application. The Maya table of ecliptic syzygies in the Dresden Codex may be interpreted as recording both umbral and penumbral eclipses of the moon. Unlike the tradition-bound modern nautical almanacs, the Maya had no reason for discriminating against penumbral lunar eclipses; they must have observed penumbral lunar eclipses visible to the naked eye along with the umbral eclipses of the moon; the Dresden Codex proves that the Maya were able to predict the date when an eclipse could occur, but we have no evidence that they could predict its magnitude. A modern table of lunar eclipses visible in the Maya territory must, therefore, contain not only the umbral eclipses available in Oppolzer's *Canon* but also the penumbral eclipses down to the limit of naked-eye visibility.

Excellent enlargements of two photographs, selected from a series secured during the eclipse of 1937 May 25, were put at my disposal through the courtesy of Dr. N. T. Bobrovnikoff; they are reproduced in Figures 1 and 2, Plate V. The original photographs were taken at the Students' Observatory, Ohio Wesleyan University, Delaware, Ohio, by Andrew Bunker and Claude Fisher; the 6-inch Brashear doublet was diafragmed to an aperture of 2 inches; Process plates were used, and the exposure time was about 1/5 second; the diameter of the moon is 8 mm on the original negatives; there was a slight haze around the moon when the photographs were taken.

The orientation of lunar maps corresponds to the usual telescopic

TABLE II

PENUMBRAL LUNAR ECLIPSES

Saros Series	Date	Magn.	λ_z	ϕ_z	Date	Magn.	λ_z	ϕ_z	Date	Magn.	λ_z	ϕ_z
L25	1900 Dec 6.4	−0.16	−158°	+22°	1918 Dec 17.8	−0.14	+ 73°	+23°	1936 Dec 28.2	−0.13	− 56°	+23°
L30	1901 May 3.8	−0.05	+ 84	−16	1919 May 15.0	−0.19	− 19	−19	1937 May 25.3	−0.30	−119	−21
L65	1904 Mar 2.1	−0.80	− 43	+ 8	1922 Mar 13.5	−0.87	−169	+ 3	1940 Mar 23.8	−0.91	+ 65	− 1
L66	1904 Mar 31.5	−0.26	+175	− 4	1922 Apr 11.8	−0.17	+ 54	− 8	1940 Apr 22.2	−0.09	− 65	−13
L72	1904 Sep 24.7	−0.52	+ 94	0	1922 Oct 6.0	−0.41	− 15	+ 5	1940 Oct 16.3	−0.35	−124	+ 9
L113	1908 Jan 18.6	−0.56	+161	+21	1926 Jan 28.9	−0.52	+ 43	+18	1944 Feb 9.2	−0.52	− 75	+15
L118	1908 Jne 14.6	−0.14	+148	−23	1926 Jne 25.9	−0.28	+ 39	−24	1944 Jul 6.2	−0.43	− 70	−23
L119	1908 Jul 13.9	−0.69	+ 40	−22	1926 Jul 25.2	−0.56	− 72	−20	1944 Aug 4.5	−0.45	+175	−17
L124	1908 Dec 7.9	−0.01	+ 29	+23	1926 Dec 19.3	−0.05	− 96	+24	1944 Dec 29.6	−0.03	+139	+23
L154	1911 May 13.2	−0.26	− 90	−18	1929 May 23.5	−0.11	+170	−20	1947 Jne 3.8	+0.03	+ 71	−22
L160	1911 Nov 6.6	−0.16	+123	+16	1929 Nov 17.0	−0.13	− 4	+19	1947 Nov 28.4	−0.11	−131	+21
L171	1912 Sep 26.5	+0.12	−178	0	1930 Oct 7.8	+0.03	+ 71	+ 5	1948 Oct 18.1	−0.06	− 41	+10
L200	1915 Jan 31.2	−1.04	− 72	+18	1933 Feb 10.6	−1.07	+164	+15	1951 Feb 21.9	−1.11	+ 42	+11
L201	1915 Mar 1.8	−0.43	+ 89	+ 8	1933 Mar 12.1	−0.40	− 35	+ 4	1951 Mar 23.4	−0.38	−157	− 1
L206	1915 Jul 26.5	−0.65	+175	−20	1933 Aug 5.8	−0.76	+ 66	−17	1951 Aug 17.1	−0.85	− 47	−14
L207	1915 Aug 24.9	−0.39	+ 40	−12	1933 Sep 4.2	−0.28	− 72	− 8	1951 Sep 15.5	−0.17	+174	− 3

appearance of the moon, with the south at the top; lunar photographs—as distinguished from photographs of the Milky Way, of nebulae, etc., —are usually inverted in this telescopic manner; Figures 1 and 2 follow this orientation. Figure 1 reproduces the photograph taken at $7^h\ 51^m$ U.T., the theoretical time of mid-eclipse; the northern part of the moon is conspicuously darkened by the penumbra. Figure 2 reproduces a photograph taken 52 minutes later, at $8^h\ 43^m$ U.T., or 78 minutes before the moment when the moon was scheduled to leave the penumbra; a comparison of Figure 2 with a typical photograph of the full moon reveals a slight darkening of the northern limb; this photographically recorded phase of the eclipse corresponded to a negative magnitude of —0.44.

In Table II are listed the penumbral lunar eclipses of the three saros cycles which coincide, roughly, with the first half of the current century; for the sake of completeness, the partial eclipses belonging to the lunar saros series L154 and L171, and falling within the framework of this table, are included. Table II was computed with the aid of Neugebauer's tables, and the magnitudes may, therefore, differ, by a few hundredths, from the corresponding magnitudes computed by other methods. In the year 1940, there will be three penumbral eclipses of the moon; the appulse of April 22 will be very conspicuous to the unaided eye; the eclipse of October 16 will be just beyond the limit of visibility, provided that its magnitude, —0.35, needs no revision.

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Ambrose Swasey

19 DECEMBER 1846 - 15 JUNE 1937

On the twentieth of February, 1935, it was my great privilege to make the address on the occasion of the presentation of the Washington Award to Ambrose Swasey. This award in the form of a handsome bronze plaque is annually conferred upon an engineer of distinction by the Western Society of Engineers. This nation has a great example in the life of him for whom the Award is named, George Washington, great in engineering and in that engineering which we call statecraft. The several recipients form an honor roll, a list of men of highest achievement.

In paying tribute now to this dear friend who has done so much for the science of astronomy, I can find no more fitting words than the closing sentences spoken in his presence on the occasion noted above, revised only to change the number of years from eighty-eight to ninety:

"Turn now to him whom we honor tonight, Ambrose Swasey. Dweller on Earth for ninety years; great in engineering attainments; in production and administration; great in ingenuity and accomplishment;

great in breadth of view; great in simplicity and forthrightness; great in sympathies and spirituality; great in appreciation of the essentials and obligations of life; 'maker of machines, institutions, and men'; a very noble gentleman, an engineer worthy to stand in the Washington succession, a worker with helping hand outstretched and heart aglow for his fellow men. I am persuaded that as he walked the Earth among us he walked with eyes uplifted toward the eternal stars."

PHILIP FOX.

The Hayden Planetarium-Grace Eclipse Expedition

By DOROTHY A. BENNETT

The Hayden Planetarium-Grace expedition to the path of the total solar eclipse, which occurred on June 8, 1937, was planned with several well-defined objectives: to photograph the eclipse with telescopic cameras, movie, and still cameras, to paint it, observe it, and describe it to the radio listeners, visitors to the planetarium, and the readers of THE SKY (monthly magazine of the Planetarium).

The members of the party went into the field equipped to carry out this program. There were two polar axes, four telescopic cameras, two driving-clocks, two small refracting telescopes, Longines-Wittehaur chronometers, one Fairchild aerial camera, seven motion picture cameras, five still cameras, and numerous personal cameras that were used for occasional shots. Many of these cameras were equipped with telephoto lenses. Then, of course, in addition to these things there was a wealth of miscellaneous expedition material including two portable dark-rooms, transits, etc., artists' canvas, binoculars, and a complete set-up for broadcasting.

This battery of equipment was to be set up in the path of the total eclipse to occur in the afternoon in Peru, along a path that stretched from the coast back of Chimbote on the central line to cross high in the mountains.

Five stations were finally selected so that every possible place where the eclipse would be well observed and reported would be used. Dr. Fisher, leader of he expedition, was located at Huanchaco, Lat. —8° 4′ 46″, Long. W. 79° 7′ 40″, where he and Mrs. Isabel M. Lewis, associate astronomer, were the guests of the Peruvian Expedition under Dr. Godofredo Garcia. Here, too, was Dr. Issei Yamamoto of Japan with his associates and equipment. This station had the highest sun, 9½°, and afforded a fine view of the eclipse in a clear sky over the Pacific Ocean. Totality occurred at $5^h\ 18^m$ and lasted two minutes and 33 seconds. Dr. Fisher made motion pictures of the progress of the eclipse, the "diamond ring," and the corona with his Akeley motion picture cam-

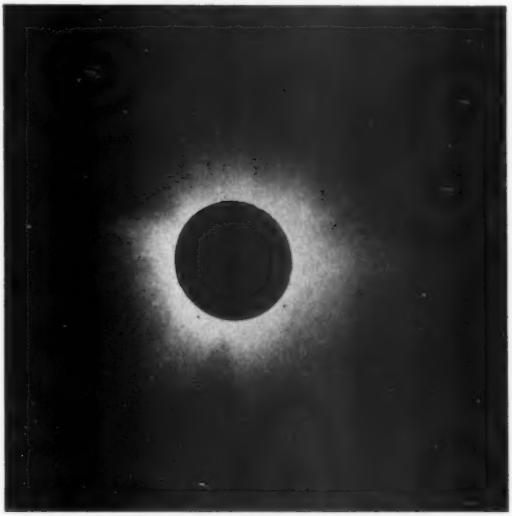
era, using a 12-inch telephoto lens and supersensitive panchromatic film. He also made color photographs on Kodachrome (supplied by Eastman) with his Graflex and with a Contax carrying a 6-inch telephoto. Mrs. Lewis used a two and a half-inch telescope and in an exposure of a thirtieth of a second with Kodachrome secured extensive corona and excellent red prominences. She also photographed "Bailey's Beads" at second and third contacts. While Dr. Fisher has yet to see his color pictures with the Graflex he can report complete success with the movies, some of which were used by the news reels. Accompanying Dr. Fisher and Mrs. Lewis were Miss Johnson, artist, and Te Ata.

HUANCHACO STATION
Issei Yamamoto, Godofredo Garcia, Mrs. Isabel Lewis, Dr. Clyde Fisher

Almost as far west and much nearer to the center of the eclipse path was the second station at Moro, Peru, (Lat. —9° 8′ 5″, Long. W. 78° 10′ 5″) under associate astronomers, Dana K. Bailey and Dr. Serge Korff. This was almost exactly on the center of the path about 40 miles inland from Chimbote in the Callejon de Huaylas. Here during the three minutes and a half of totality, eight exposures were made with a 6-inch lens having a 72-inch focus and a 6-inch lens having a 90-inch focus. With the 90-inch, Korff made five exposures on Eastman 40 plates (backed with blacking the night before the eclipse) according to

the following exposure schedule: 1^s, 4^s, 8^s, 16^s, 4^s, 24^s, 32^s, 51^s. In addition to these, two exposures on Kodachrome, one of which was lost through a faulty holder, were made. With the 72-inch, Bailey made eight exposures, six on Eastman 1G spectroscopic plates and two (numbers 5 and 6 as with Korff) on 4x5 artificial light Kodachrome supplied by Eastman, using a type A filter. His exposure schedule was the following: 2^s, 4^s, 8^s, 16^s, 2^s, 12^s, 32^s, 37^s. One of these Kodachrome exposures also was lost because of the faulty holder.

The two Kodachrome exposures were mailed to Rochester for development along with two exposures during totality on 35 mm Kodachrome taken by Bailey on his Retina. The 35 mm have been returned and are excellent, showing not only the whole spectacle of totality in the



EIGHT SECONDS EXPOSURE AT TOTAL PHASE WITH SIX-FOOT CAMERA, BY DANA K. BAILEY AT MORO, PERU

true color of the corona but also sky and sunset shades at the horizon with surprising faithfulness. The 4x5 have not been returned at the time of this writing. The other plates were given careful development in D-76 at uniform temperature, and some show wonderful detail and extreme extension of coronal streamers to beyond two solar diameters. Volunteer Alberto Barrios operated Dr. Korff's Graflex, which carried a 17-inch telephoto lens, and made a sequence of exposures of the progress of the eclipse and some others not yet developed. Using a pendulum devised at Mr. Rosenshine's Colquipocro mine where the group first located, Mrs. Korff was time-keeper for the group.

The other polar axis was at an altitude of 15,000 feet in the Andes at Cerro de Pasco, Peru, (Lat. —10° 43′ 36″, Long. W. 76° 15′ 54″) where William H. Barton, executive officer of the expedition, was in charge of the station with Charles Coles, photographer; D. Owen Stephens, artist; and Dorothy Bennett, observer. Here were mounted two telescopic cameras, one 6½-inch Ross lens with 84-inch focus and a 4-inch lens with 136-inch focus, to take advantage of the 143 seconds of totality. These lenses as well as the driving clocks for each station and the 6-inch lens with 72-inch focus were loaned by Swarthmore College through Dr. John A. Miller, who acted as Technical Director of the expedition. Eight exposures were made with each of these cameras on the following schedule: 1^s, 4^s, 16^s, 24^s, 16^s, 8^s, 1^s. Due to the slipping of the axis from an unknown cause, some plates from the 136-inch were lost, but a fine set of negatives was obtained from both this and the 84-inch. Dr. Miller says that the plates are not only both sharp and useful, but are among the finest he has ever seen.

The motion picture program at Cerro was carried through with 35 mm Eyemo with 20-inch Zeiss triplet f3.8; 35 mm DeBrie with 12-inch, f5.6 telephoto; 35 mm Eyemo with 6-inch at f4.5; 35 mm Sept. with 16-inch lens at f4.5; and 16 mm Filmo with 3¾-inch telephoto at f3.3. From the Eyemo carrying the 6-inch lens came satisfactory pictures of the corona made at 4 frames per second, and from the Filmo using Kodachrome, at 8 frames per second, a sequence at the end of totality in which the prominences are over-exposed, but the corona is satisfactory and very bright.

Visual observations of the eclipse made by Dorothy A. Bennett included sketches of the corona and locations of the prominences which were used by Mr. Stephens as a check upon his own observations as well as a record of the various phenomena which occurred at the time of the eclipse. The corona was seen to extend to more than a diameter and a half and six groups of prominences were recorded. Two of these near the sun's western edge were gradually revealed by the passing of the moon and at first appearance seemed to be rising rapidly—but the same two actually were eruptive as the upper extensions changed noticeably under observation, rising and swirling to a full tenth of the sun's diameter. Shadow bands were seen just before second contact and Mr. Stephens reported that he saw Mars on the eastern horizon just as the shadow was receding. Mr. Bailey from Moro reported that he saw Mars, the Southern Cross, Canopus, Sirius, and stars down to the third magnitude.

At Cerro, too, D. Owen Stephens made for the Junior Astronomy Club an excellent record of the phenomenon on four paintings which were finished in the week following the eclipse. This was the third eclipse that Mr. Stephens had observed scientifically with the express purpose of making an accurate record of it in color. Unusually well qualified for such a task was this Swarthmore-trained student with ma-

jor in astronomy who came from a long line of artists. He combined to a rare degree an artist's eye with a scientist's mind.

He made a 30x36-inch canvas of the "diamond ring" at second contact which is particularly beautiful and one 48x72-inch of totality which represents the corona with remarkable transparency and shows the wealth of streamers, arches, and brushes that were observed, as well as the prominences. The most unusual one is the 30x36-inch canvas showing the retreating shadow with Mars barely visible and the startling first-light on the ground after totality. Then he also delineated the sun setting like a crescent moon over the snow-capped peaks of the Andes.

Add to this the very delicate and interesting canvas of the zodiacal light, which was made before the eclipse, and the most impressive 48x72-inch canvas of the southern Milky Way, which pictures the rich star clouds in Sagittarius and Scorpio, and you have before you a beautiful group of paintings as well as a scientific record of which both painter—and astronomer—Stephens could well be proud. It was the greatest of tragedies that this able member of the expedition did not return to New York. He died of a thrombotic stroke in the Gorgas Hospital in the Panama Canal Zone.

To successful programs from the most western station, the most central station, and the highest land station, was added a surprisingly effective group of results from the Pan American Airways plane, piloted by Disher and Gray, in which Major Albert W. Stevens made still pictures with a Fairchild Aerial Camera with a 24-inch Bausch and Lomb lens at f6. One image secured showed the moon 6 mm in diameter and a radial extension of the corona of 11 mm. There is excellent detail even on the short exposures, and the 16 mm Cinè-Kodak Kodachrome movie is reported from Rochester to be good. Major Stevens has already started work on the improvement of this aerial equipment to make it even more useful for future eclipses, because the aerial photography bids fair to be a most valuable adjunct to the work on terra firma.

To carry a word picture of the wonderful spectacle of the eclipse to a large number of people, Mr. Adamson, in charge of Public Relations for the Museum, Mr. William Perry and Mr. Raymond Newby of Columbia Broadcasting Company, arranged to broadcast a description of it from the mountains at Pira. The difficult task of running a line there was cared for by Mr. Newby. Mr. Perry was official announcer for Columbia.

To Miss Sally Pyle, secretary of the expedition, fell the task of coördinating, in Lima, messages from all the staitons.

The personnel of the expedition was as follows:

Dr. John A. Miller, Emeritus Director of the Sproul Observatory, Technical Director, who did not accompany group.
Dr. Clyde Fisher, Curator of the Hayden Planetarium, Leader.
Mr. William H. Barton, Associate Curator of the Planetarium, Executive Officer.
Dr. Serge Korff, of the Carnegie Institution, Associate Astronomer.

Dana K. Bailey, of the Steward Observatory, University of Arizona, Associate Astronomer.
Mrs. Isabel M. Lewis, of the Naval Observatory, Associate Astronomer.
Dorothy A. Bennett, Assistant Curator of the Planetarium, Observer.
Charles H. Coles, Chief Photographer of the A.M.N.H., Photographer.
D. Owen Stephens, of Moylan, Pennsylvania, Artist.
Mr. Hans Christian Adamson, Public Relations, A.M.N.H., Publicity.
Mr. Raymond Newby, Columbia Radio Engineer.
Mr. William Perry, Columbia Radio Announcer.
Miss Sally Pyle, Secretary.

The following persons accompanied the group, assisting in various capacities:

Senors Runcie and Barrios, of Lima.
Messrs. Deadman, Graph, McQueen, Sigaro, and Philpott, of Cerro de Pasco.
Mrs. William H. Barton, Mrs. Serge Korff, Te Ata (Mrs. Clyde Fisher), Mrs. Hans Christian Adamson, Mrs. Raymond Newby and child.

Observations near the Noon Point of the 1937 Eclipse

The total solar eclipse of 1937 June 8 was observed from mid-Pacific by Dr. John Q. Stewart, representing Princeton University, and James Stokley, representing the Franklin Institute and the Cook Observatory. They were on board the freighter *S.S. Steelmaker*, of the Isthmian Steamship Company, which is a subsidiary of United States Steel. The location at totality was 130 degrees 38 minutes West, 9 degrees 50 minutes North—about 1850 miles ESE of Honolulu and 1300 miles from the nearest land. Mid-eclipse was observed at 11:30:27 A.M., 135th meridian time. A duration of totality of 7 minutes 2 seconds was indicated by the *Almanac* for this position, as compared with the maximum 7 minutes 4 seconds at the exact center about 220 miles farther east. The ship was moving east with the shadow, and the observed duration of totality was 7 minutes 6 seconds.

Dr. Stewart arranged the trip, with the coöperation of his Princeton classmate, Mr. Donald Morrison, of the American Hawaiian Steamship Company, who found that the "southern route" from the Hawaiian Islands to the Panama Canal almost coincided for more than a thousand miles with the eclipse-track, and who introduced him to Captain Logan Cresap, Isthmian's Marine Superintendent. Ships of that line on their regular trips sometimes use the "southern" instead of the shorter great circle track when coming east, because of more favorable winds and currents. Knowing of Stokley's interest in the ocean observation, Stewart included him in the arrangement: two astronomers were to be carried as guests of the Isthmian Company from the Islands to a North Atlantic port; it was by no means certain that a ship would be passing through the path of totality at the proper date. After less than a week for preparation, Stewart and Stokley proceeded by rail to the west

coast and by the *Malolo,* a Matson passenger liner, to Honolulu. There on June 1 they boarded the Isthmian's *Steelmaker,* commanded by Captain Earl D. Lucas, placing themselves under his command as "pursers." He enthusiastically coöperated in every way consistent with proper operation of his ship. He made many sextant sights of stars, planets, and sun, to fix the position at eclipse time with precision. The other officers, as well as the crew, also aided vigorously. For the duration of totality the ship became a small floating observatory.

A full account of results will be given later; in a preliminary announcement Stewart and Stokley summarized the following general points:

(1) An unexpected remarkably high haze formed a thin screen on which the moon's shadow was projected, moving east. Sunlight outside the shadow, at distances in excess of 75 miles, was scattered by this screen, with consequent great diminution of the expected darkness. Only the brightest planets and stars were seen, newspaper print could be read easily. Angles measured at the beginning, middle, and end of totality show that the haze was 15 to 20 miles high. This experience emphasizes what the textbooks barely suggest—that darkness at solar eclipses is as much dependent upon atmospheric conditions as upon the diameter of the moon's shadow.

(2) In consequence of this general illumination, Stewart was disappointed in his expectation of measuring unusually long extensions of the coronal streamers. The remarkable clarity with which this corona—only 14 degrees northward of the zenith—was seen made up for the disappointment. The high haze did not obscure it. Due to the large moon, the inner corona appeared as an unusually narrow and pure white ring. The remainder of the corona exhibited none of the amorphous character which common opinion ascribes to it. From his own inspection, and from compilation of the opinions of Stokley and the amateur observers of the *Steelmaker,* Stewart has come to the conclusion that, so far as low-power glasses could reveal, this corona was composed entirely of "spouts" of light extending radially from the sun; and, further, that the atoms responsible for the corona's clear-cut, steely glow probably are not in anything approaching static equilibrium but may be moving continually away from the sun.

(3) Stokley brought the equipment for measuring the corona's brightness in two ways. One, a Macbeth illuminometer, he used personally; the other, photoelectric cells and microammeter, was operated by Mr. Eugene Loeffler, the ship's radio operator, with the collaboration of Messrs. Mackenzie and Derlin. Subject to further study and correction, these results indicate that the corona was between 1.0 and 1.5 times the brightness of the full moon.

(4) Photographs were taken by Stokley, using two Leica cameras, one with a 200 mm lens, the other with a lens of 150 mm focal length. Some were in color. The images show considerable detail.

(5) The two observers are of the opinion that their experience establishes the practicability of certain types of eclipse observations at sea. Had they known that shipboard conditions would be so satisfactory, and had more time been available for preparation, heavier apparatus could have been taken. They believe that marine observations should be made of interesting total eclipses whenever the point of maximum duration occurs far from land. With some three-fourths of the earth covered by water, more than half of all eclipses are so placed.

Meeting of Section D (Astronomy), of the A. A. A. S., at Denver, June 24 and 25, 1937

By N. W. STORER*

Two sessions of Section D in conjunction with the Astronomical Society of the Pacific were held in the auditorium of the Denver Y.W.C.A. Dr. Philip Fox, Vice-President of Section D, presided at the morning session, and Dr. J. S. Plaskett, Director Emeritus of the Dominion Astrophysical Observatory, was in the chair for the afternoon session. The attendance was between thirty and forty.

A western meeting of astronomers might be expected to derive its chief support from the great western observatories, and this was found to be the case at the Denver Meeting where only three out of the twenty-two papers on the program originated east of the Rockies.

The Dominion Astrophysical Observatory, Victoria, B. C., contributed the largest number of papers, seven being presented by Dr. C. S. Beals for various members of the staff.

W. E. Harper reporting a study of Nova Lacertae, 1936, found that the outburst which caused the star to increase 150,000 fold within a few days, had resulted in three expanding shells of gas, the largest having the greatest velocity yet found in a galactic nova, 3600 km/sec.

J. A. Pearce, comparing his own spectroscopic orbit of RZ Cassiopeiae for the epoch 1936 with that of F. C. Jordan for 1912, found conclusive evidence of apsidal rotation in a period of 18.3 years $\pm$ 1.2 years, confirming the photometric prediction of R. S. Dugan.

C. S. Beals and G. H. Blanchet showed that an unidentified band in the spectra of 46 stars, centering at 4430.5 A and possibly of molecular origin, was of nearly constant wave-length whether in the spectra of high or low velocity stars, and showed enough correlation in intensity to interstellar calcium lines to suggest interstellar origins for this band also.

C. S. Beals also reported that both the stellar and interstellar lines of

*Secretary pro tempore.

Na I showed a greater intensity than they should when compared to Ca II lines, apparently requiring a revision of theory on that point.

R. M. Petrie described a device for the measurement of spectrograms, by which enlarged images of both the spectrogram and the micrometer screw head are projected on a white plate at a convenient distance from the eye, thus greatly reducing eye strain without evident loss of accuracy.

C. S. Beals reported on the spectroscopic orbit of H.D. 109,510, in which the velocity curves for both components were of equal amplitude, showing that the stars had equal masses and therefore different spectral types since the spectra were unequally intense.

Andrew McKellar also reported the orbit of the spectroscopic binary H.D. 214,652.

The Mount Wilson Observatory staff contributed five papers, all of them presented by Dr. A. H. Joy.

S. B. Nicholson and Mrs. Mulders, reporting on the present state of solar activity, predicted that the next sun-spot maximum would be reached at the beginning of 1938. This was based on an extrapolation of the graph showing the decreasing latitude of spots to that latitude obtaining at the times of the maxima of 1918 and 1928. A number of slides were projected showing recent large spot groups.

W. S. Adams and Theodore Dunham, Jr., reported their failure to detect lines of water vapor in the spectrum of Mars, though exposures of five to six hours were made at a time when the planet's velocity was sufficient to completely separate those lines from the ones due to the earth, indicating that the atmosphere of Mars probably contains less than 5% as much water vapor as is present in our air.

A. H. Joy told of progress on the exhaustive study he is making of the 309 galactic Cepheids now known. A graph was shown illustrating the increase of velocity range and light range with increasing period.

P. W. Merrill described an investigation of interstellar sodium lines and showed that these correlate in intensity with the distance as determined spectroscopically. The intensity ratio, D_2/D_1, was found to vary contrary to theory, and, since it was sensibly the same in both components of telescopic binaries, the suggestion was made that the sodium is concentrated in clouds rather than being uniformly distributed through space.

R. B. and A. S. King announced a new determination of the solar temperature based on f-values for the intensity of multiplets in the spectra of Fe I and Ti I as found in the laboratory. The temperature found for the sun was 4480° K, which is somewhat lower than the values previously assigned, but it was pointed out that it could not be ascertained to what level in the sun's atmosphere this temperature applied.

From the Lowell Observatory, E. C. Slipher told of recent work on the planets, in which the newer emulsions and filters have made it possi-

ble to make photographs in six separate spectral regions. Previous conclusions have been confirmed that Mercury keeps the same face toward the sun, and that the solid surface of Venus has never been seen. On Jupiter and Saturn the clouds are found to have marked colorations, some being visible on photographs in one color but not in another. Evidently there is only a thin layer of very clear atmosphere above the clouds. Studies of Mars revealed that its atmosphere is two or three times as opaque to ultra-violet light as that of the earth, though occasionally certain markings, such as the Syrtis Major, normally invisible in ultra-violet light, become quite distinct.

James B. Edson utilized photometric measurements at the edge of a photographic image of a planet to determine the resolving power of a composite of several individual photographs superposed. He found an average resolving power of 0″.31, and on one composite of nine images a resolution of 0″.17. In this case he was able to show photometrically that one of the so-called canals had a finite width on the photograph.

Clyde W. Tombaugh discussed the clustering of faint nebulae observed in the course of his planet search program in the Perseus-Andromeda region. By the decrease in density outward from the center of a condensation, he distinguished between true clusters and accidental groupings.

Two papers from the Lowell Observatory, "A determination of the amount of carbon dioxide present above the reflecting layer in the atmosphere of Venus" by Arthur Adel, and "The sodium content of the head of the great day-light Comet Skjellerup, (1927 *k*)" by Adel and V. M. Slipher, were read by title, as was also a paper on "Color indices in reflection nebulae" by O. C. Collins of the Yerkes Observatory.

Joseph Kaplan of the University of California in Los Angeles showed by means of slides some results of a study he is making of auroral afterglows. Glow discharges in tubes of gas so rare that exposures of from two to twenty days are required give spectra similar to the upper atmosphere and are useful in studying conditions in that region.

Miss Sophia Levy gave some results of an investigation by herself, A. O. Leuschner, C. M. Anderson, Jr., and Miss Ellen Barndollar, on the Hecuba group of asteroids, or those having about half the period of Jupiter. Certain terms in the eccentricities and inclinations had not been included in the Berkeley Tables of Perturbations, and it is now hoped that by including these a representation of the positions of these asteroids within one half a degree may be made over a period of 100 years.

President D. W. Morehouse of Drake University described work being done on the reddening of 4500 stars in 23 clusters by absorption in space. With the equipment used the probable error of a photographic magnitude is 0.027 mag., while that of a photovisual is 0.108 mag. It is hoped that the latter may be reduced with some newer emulsions which may make a filter unnecessary and reduce the exposure times.

N. W. Storer of the University of Kansas explained and demonstrated a mechanism by means of which a small sphere on an extensible radius turned by a uniformly rotating shaft is made to duplicate exactly the motion of a particle in a Keplerian ellipse of eccentricity 0.4. It was also shown how the sphere may illustrate longitudinal libration.

In an invited supplementary discussion, Dr. J. S. Plaskett and Mr. Warner Seely, of the Warner and Swasey Company, told extemporaneously of the progress of the 82-inch reflecting telescope for the McDonald Observatory. Unique features mentioned were (1) the fact that the declination axis does not project through the polar axis, thus simplifying the use of the telescope in the Coude form; and (2) the correction for differential refraction both in hour angle and in declination which is being incorporated into the drive mechanism.

This concluded the sessions devoted exclusively to astronomical subjects.

On Friday morning, June 25, a joint session of Section D with Section B and the Astronomical Society of the Pacific was held to hear four invited papers on phenomena of the upper atmosphere. Dr. Philip Fox, Vice-President of Section D, was in the chair and about sixty were present.

N. E. Bradbury of Stanford University, speaking on "Fundamental mechanisms in the Ionosphere," reviewed the evidence derived from radio phenomena that several ionized layers having different properties exist in the upper atmosphere, and also the evidence that this ionization is caused by the sun. He distinguished the D-layer at an altitude of about 50 km, the E-layer (Kennelly-Heaviside Layer) at 100 km, and the F_1 (200 km) and F_2 (300 km) layers. The radio technique for measuring the altitudes of these layers was described, and also the theoretical considerations which lead to the computation of ion densities in these layers of from 2×10^5 to about 10^6 ions per cubic centimeter.

Dr. J. C. Stearns of the University of Denver abstracted a paper by J. H. Dellinger of the National Bureau of Standards, on "Sudden disturbances in the Ionosphere," in which were noted several instances of a sudden and complete fading out of radio signals above 1500 kilocycles frequency. These occurred simultaneously (within three minutes) over widely separated portions of the earth's surface, and were accompanied by magnetic and other disturbances. Such effects always occur on the sun-lit side of the earth and are most pronounced in localities where the sun is near the zenith. They accompany solar outbursts.

Dr. A. H. Joy presented a paper for R. S. Richardson of the Mount Wilson Observatory on "Bright Chromospheric Eruptions." These usually occur near spots,—between the two in the case of double spots, and they show up only in the line emission spectrum of the chromosphere, not at all in the continuous spectrum of the photosphere. About 11% of spot groups show eruptions and only about 7% of these are of marked intensity. Successive eruptions often recur at the same point on

the sun's surface, on one occasion six being noted within nine hours. There is a marked tendency for two or more eruptions to occur simultaneously at widely separated places on the sun. This occurs far too often to be the result of chance. A recent modification of the spectroheliograph will make it possible to get a one-inch spectroheliogram every four minutes, and thus obtain a much more nearly continuous record of the occurrence of these outbursts.

A. G. McNish of the Carnegie Institution of Washington spoke on "Terrestrial magnetic variations and the Ionosphere." He said the ultraviolet solar radiation causing the ionization is undoubtedly much more intense than that expected from the sun's black body radiation. He estimated that there is about ten times as much ionizing radiation from the solar flares referred to by Dellinger and Richardson as from the sun's normal radiation. Since this seems to be due to bright line emission,—the Balmer Series of Hydrogen and probably the Lyman Series also,—it was suggested that possibly line emission is the usual cause of ionization rather than black body radiation. The startling fact was mentioned that the sun's ionizing radiation appears to increase from sun-spot minimum to maximum by a factor 16. In conclusion it was noted that while the direct effect of solar disturbances is most marked at the subsolar point, the magnetic storms affect only high altitudes so that, for example, New York to London radio messages have to be routed by way of Buenos Aires.

Pilgrimage to a Tropical Observatory

By E. P. MARTZ, Jr.

A general discussion of a trip to the Private Observatory of Professor William H. Pickering, at "Woodlawn," Mandeville, Jamaica, British West Indies, in the spring and summer of 1936; and a brief, preliminary summary of observational programs and results undertaken there by the author; with a description of the Observatory, instruments, and Professor Pickering's work.

The West Indies! Blue tropic seas;—crystal clear night skies filled with myriads of close-packed stars, brilliant planets, and a giant silver Moon riding high;—yet so close that it seems one could reach up and touch them! Visions to conjure with, these.

In March, of 1936, my eyes and feet turned southward. In that winter of unprecedented cold, misery, and disaster for the North, before my mind's eye waved only stately tropical palms; nestled a cluster of telescopes turned toward tropical heavens; lay the tropics, and wonderful opportunities for astronomical observation, beckoning. So, when the opportunity appeared, I left the cold, cloud-covered North anticyclone latitudes, where observation of the stars, and in particular of the planets, had proven hopeless for that winter, I left the United States

and sailed from New Orleans for that tropical island, Jamaica, in the British West Indies.

Some months earlier, Professor William H. Pickering had very kindly indicated that I might have the pleasure and privilege of observing and working under his guidance during the coming spring and summer, at his home and private observatory, "Woodlawn," near Mandeville, Jamaica, B. W. I. Professor Pickering has been known for many years as a peer of planetary astronomers, through his numerous papers published in POPULAR ASTRONOMY, the *Annals of Harvard Observatory*, and elsewhere, since 1890. His work at Cambridge, at Mount Wilson in the early years, at the Harvard Station in Arequipa, Peru, with Percival

PROFESSOR W. H. PICKERING AND HIS 12.5-INCH CALVER REFLECTOR.

Lowell at Flagstaff, and in Jamaica, is well known to all who have followed modern astronomical development. The brother of the late, long-time Director of Harvard Observatory, Professor Edward C. Pickering, William Henry Pickering is known throughout the world as one of the foremost men in the development of lunar and planetary astronomy, as well as early astronomical photography, novae, and cometary theory. Who would not seize, joyously, such an opportunity, to work under such a man, if it were offered and circumstances allowed the acceptance of it? I know that I should have regretted it all my life if I had let this experience pass me by. So it was, that the end of March, a cold desolate northern March, saw me packed and leaving Chicago for the tropics, on an astronomical pilgrimage; the happy memories of which will live with me always.

I was to sail from New Orleans, Louisiana, on March 28. En route to New Orleans from Chicago, I spent a delightful day and night in Nashville, Tennessee, with the well-known amateur astronomer, Latimer

J. Wilson. I was met on my arrival in Nashville by the kind, smiling man with whom I had been corresponding for some time. He did everything to make enjoyable my much-too-fleeting visit with him and with Nashville. We hurried off to meet a number of the active amateur astronomers of his city. Then followed a very full day of most interesting discussion on the astronomical and instrumental problems and activities so close to us all; a fascinating afternoon with Mr. Wilson and his sister at their home, poring over his observations of the planets, in particular Mars. His exquisite photographs of the stars and planets were made with his 11-inch reflector, by manual guiding, without any clockwork or slow motions at all! Lantern slides, globes of Mars for many years past; all based on observations he has made with his fine 11-inch speculum, but with mountings and machine equipment that most persons would consider totally inadequate for any but the crudest work. In Nashville, they call Latimer Wilson "The Wizard," because of the wonderful photographic and visual results he obtains with little more than a mirror, ". . . a toothpick, and a piece of string."! His results are astoundingly good, and bear evidence that his observational and photographic techniques and abilities are truly worthy of the great city which gave birth to another man who started as an amateur astronomer, and whose work is also unexcelled:—the beloved Edward Emerson Barnard.

Dinner in Nashville with Mr. Wilson and two radio engineers of station WSM; brothers, the Messrs. DeWitt; ardent and gifted amateur telescope makers. The evening was spent at their private observatory near their suburban homes. Though the night was hopelessly cloudy, their beautifully engineered 12-inch, F:5, photographic reflector with 4-inch guiding refractor, dome, and clockwork, was a sight to gratify the eyes of any astronomer or instrument man, despite the forced impossibility of using it that night. A long and intensely interesting evening talking telescopes, planets, stars, made it difficult for me to leave Nashville, and my new found friends the next afternoon. However, before me constantly was the vision of the blue Caribbean and clear skies.

New Orleans. Cosmopolitan city of the Gulf; clean, sootless buildings lining broad, palm-festooned streets; a blazing Sun, warming a heart and body still cold from the frigid Midwest; pleasant, kindly people, wearing straw hats, panamas, and spotless linen suits; white and striped linens, and waving palms—in March! A sight to make one unaccustomed to it gasp with surprise and delight. A busy waterfront stretching into the far distance. Wharves filled with bales and crates being industriously loaded aboard great white steamships and black freighters, bound soon for the distant, romantic ports which we had envisioned all our childhood, but never thought to see. A feeling of unexcelled joy and exhilaration as we watch the "Blue Peter," our sailing flag, being hoisted aloft the ship. And then, a settling down, with the expectation of an early departure . . .

Mobile and Tampa were visited first for freight consisting of logs and supplies for the islands; and then, the open sea. Our ship was a trim, clean, aluminum painted freighter of 5000 tons,—the *S.S. Vestvangen.* This was one of six sister ships used by the Aluminum Company of America for carrying Bauxite, the basic aluminum ore, to the States from the jungle quarries of the Surinam, Dutch Guiana; a Norwegian ship; a young, smooth-shaven, Norwegian crew; and the "skipper," a delightful and cultured Norwegian, Captain Oren.

Much interest was displayed by my eight fellow passengers in the extraordinary framework case and my white enameled telescope tube it protected. This I had determined to bring with me to Jamaica, despite the difficulties of portage due to its size (eight feet long and one foot square). Their amazement was evinced at ". . . a telescope of that size!"; though I assured them of its punyness compared with the vast majority of astronomical telescopes. Probably my companions, (like my neighbors in Chicago, who cannot see what would prompt any *sane* person to sit up all night looking through a *"telescope"*!), considered me just a bit "off balance" for traveling the 2000 miles from Chicago to Jamaica, ". . . just to look at stars."! I suppose, that with other amateur and even professional astronomers, I must admit that the possibility exists! Young has told us in his "Night Thoughts," that: ". . . The undevout astronomer is mad." Perhaps this holds for the devout as well!

The blue, blue, *blue, Blue* Caribbean! Hard to imagine anything like it that is real. The clear blue sky, intense white cumulus clouds, and blazing Sun, make with the sea a wholly exquisite and delightful vision. And one thrillingly real; for *this* is the Spanish Main of pirate days; no less beautiful or romantic in the present. At night with the waters softly lapping at the ship, the phosphorescence in the floating seaweed glows suddenly, and is gone. Like ashes in the water,—silent, gentle, glowing softly. And the skies! Though the white splendor of the growing Moon dimmed the full glory of tropic heavens, it was fascinating to watch as the familiar southern stars and planets rose higher, overhead, as we drew nearer the equator, and the northern polar stars sank down below a clear sea horizon.

One night the First Mate took me to the Bridge to see the sailing of the ship from there. He was interested in the applications of the navigator's triangulation methods to astronomy, and we talked of this, and stars, and navigation for several hours. The reality of seeing sixth magnitude stars with the full Moon out, was somewhat startling to me. What would I not be able to see without the Moon to dim their light?

On the morning of April 6, at 6:00 o'clock, I looked out of our cabin porthole, and there, in the misty distance, was the northwest tip of Jamaica,—a mountainous green band on the horizon. Beautiful, clustered white clouds billowed over it, protectingly. Blue waves, breaking white, on sandy, palm-fringed shores. It was very delightful to the eye;

but the best was yet to come . . . We sailed along the coast all day, raptly watching those beautiful shores. Just after dark, that evening, the lights of old Port Royal, and of Kingston, were sighted in the far distance. They sparkled in the bay; a vast grey bulk of mountains looming up behind them. Slowly the ship rode into the great bay with the full Moon shining down in all its splendour on the city, and the mountains, and the sea. The perfect beauty of the sight as we neared Port Royal, on a narrow spit across the bay from Kingston, was almost indescribable in words.

Our anchor dropped in the bay that night, as we waited till the day for the Port Doctor and the Customs examination. The morning Sun, rising out of the mists and the mountains above and behind the city, showed to us the intense and inspiring vision of the city of Kingston, nestling amid tall and swaying Royal Palms, thrusting here and there a domed roof or a glistening white building into view. White ships sparkled at us from the long expanse of docks and wharves. The realization that *this* was the tropics came forcibly to our enchanted eyes and minds.

Because of the kindness of Professor Pickering in writing to the Colonial Secretary in my behalf, I had no trouble whatsoever with the customs in regard to my baggage or my telescope. Once through, I had the telescope shipped by rail the 60 miles inland to Williamsfield, near Mandeville, to await me there. Then to the delightful task of buying my first tropical clothes; white linen suits ("whites"), shoes, a sun helmet or "toupee," for the blazing heat of the midday Sun was terrific. An adventure in itself, this was. An exciting, if murderously hot, day followed, as I made myself acquainted with the second largest city in the Antilles. The strangeness, newness of it all was overwhelming, and as intoxicating as the strong Jamaican Rum.

Three days were spent in Kingston imbibing the feeling and atmosphere of the tropics; during which time I found the absolute necessity of slowing down one's actions, one's gait when walking, and even one's thoughts, under the influence of the hot tropical sun and the sea level humidity. Short bursts of rain, pouring down violently, came every day several times, (in fact, one had greeted us on landing), but these would vanish as suddenly as they had begun, and in fifteen minutes under the blazing sunlight, one would never have suspected that it had been raining, so rapid was the evaporation and run-off of the water. My first exquisite tropic nights were spent at a small hotel in the mountain suburbs above the city,—Mona Great House, in the parish of St. Andrew. There we watched the brilliant, white Moon rise majestically over the eastern Blue Mountain range, and the hosts of stars making the nights beautiful. Many new stars and constellations were visible from our southern latitude, and many of our old friends of the northern skies appeared almost unrecognizable and startling in their new positions in the heavens. But these sights took my mind from the novelty

of Kingston and the mountains, and before my eyes the cluster of telescopes, turned heavenward, again appeared, and I longed to reach "Woodlawn," and start observing at once. . . .

A Kingston railroad station filled with hustling native porters. Beggars and children clustering after the white visitor, loudly begging tips. A hot, sticky day; and then, off on a train packed with Jamaicans and a few British, for the interior. The sixty-mile ride on the bumpy, dusty, slow train was made enjoyable, and even pleasant, for me by the entertaining young English artist who joined me in my compartment. He was interested slightly in astronomy, and I, in the same manner, in art. Several hours of conversation on these, and about Jamaica, India, England, —the Empire. Fleeting glimpses, between words, of picturesque towns and native villages rolling past; of our train climbing out of Kingston, north, into the long ascent to the mountainous plateau which rises over the whole northern end of the island. Tropical vegetation, becoming denser as we rise; knobby hill topography; deep ravines and high peaks; all these delighted and satisfied one whose life had been spent mostly in the flat featureless prairies, and dirty dusty cities of the midwest. And then, before I realized the passage of time, my station, Williamsfield, was called. Bidding goodbye to my British friend, I was hustled into a waiting rattle-trap old car, my telescope and baggage assembled from the station-master by the Jamaican driver, and we were off,—up and down a hilly gravel road winding toward Mandeville, six miles away.

True to what the guide books say, Mandeville is like nothing so much as a picturesque, ". . . typical English country village; but with that which *no* English village can boast,—a *perfect* climate." We went two miles south of the town, along another winding mountain road, lined with intensely colored, verdant tropical foliage. There, a clean little stuccoed cottage atop a small rise, was the home of Miss Jane Reynolds, where I was to stay for more than three months while working with Professor Pickering. She met me, a delightful, kindly, and motherly Jamaican lady, who had spent much of her life in the United States. My good fortune was soon made evident through her unsurpassed ability as a cook, and in the wonderful meals I was treated to throughout my stay at "Delbrook," Mandeville.

The next morning brought the moment for which I had been waiting, and working toward, when, after a short half-mile walk beneath tropical verdure, I reached "Woodlawn." One rounds the bend in the road, and sees a knob-like hill some hundred feet or so in height. At the base, along the road, which winds half way around the hill, is a low wall of the encrusted, weatherbeaten limestone boulders characteristic of all this region; now overgrown with vines and thick clusters of bamboo. And then, on the south, a wide latticework road gate, flanked on both sides by spreading Royal Palms at least fifty feet high. Up from the picturesque gateway winds a white gravel road, steeply, to the top of the hill. As one walks slowly, admiringly, up to the summit, a break in the foliage

gives a superb vision of the vast, deep, misty valley on the east; and in the far distance, a broad range of mountains glimmers on the other side. The top of the hill is lost in a mass of brilliantly colored tropical foliage of every type and description. Truly a nature lover's paradise. Nestled amid this luxuriance is the low rambling house, made entirely of mahogany (to resist the termites), and well over a century old. Before the house, completely covered with vines and flowers hanging festooned from the eaves of the wide porch roof, is a broad cement barbecue, with steps from it leading down to another tropical garden. It was there, under the flower-covered porch roof, that I first met Professor and Mrs. Pickering. . . . Professor Pickering in tropical white linens. A very pleasant, strong face, with heavy mustache and full goatee, grayed by many years of prolific work. Two, young, and brilliant, active eyes twinkling at me kindly, with a wealth of welcome in them.

And Mrs. Pickering, a worthy companion for her illustrious husband; kind, helpful, doing everything possible to make my stay in Jamaica a memorable and happy experience. I shall not soon forget that meeting or the days that were to follow.

Professor Pickering and I sat for several hours on the porch swing, surrounded by the very essence of the tropics, talking of the work that I was to do while I was in Jamaica. He showed me maps of Mars: Lowell's, Flammarion's, Antoniadi's, those of Jarry-Desloges, and those of Pickering himself. We talked of the pressing need for a new, comprehensive map, encompassing all of these separate, seasonal maps, and published in a form best adapted to the actual observer. It was decided that a major portion of my daylight work would be to help in the preparation of this map, which Professor Pickering already had well under way. This was to be a composite map from all the drawings made by the "Associated Observers of Mars," published in POPULAR ASTRONOMY since 1914 by Professor Pickering as secretary of the Association. His "Mars Reports," covering many observations over a long period of years, made by himself, A. E. Douglass, G. H. Hamilton, T. E. R. Phillips, Latimer J. Wilson, and many others, today are a classic in the literature regarding our neighbor planet.

Finally, our thoughts turned to the question of observational work; the thing which had been foremost in my mind in coming to the clear skies and fine "seeing" of the West Indies. We walked a hundred feet or so to the west, rounding the house, and coming upon a dense clump of shrubbery and bamboo. I was led down a short series of cement steps, off the flat expanse of the barbecue, and thn a metal covered, sliding roof cover, about eight by twelve feet at its base and seven feet high, met my eye. We pushed upon it, toward the house, and it slid smoothly eastward on the heavy rails which its wheels rolled upon, disclosing the 12.5-inch Calver reflecting telescope. This telescope is pictured and described in two papers by Professor Pickering in POPULAR ASTRONOMY, November, 1926, and March, 1930. It was built many years ago in

England, but the fine workmanship of the Calver firm is still evident in its extraordinarily solid rigid mounting and in the fine definition of the speculum, once it was properly resilvered.

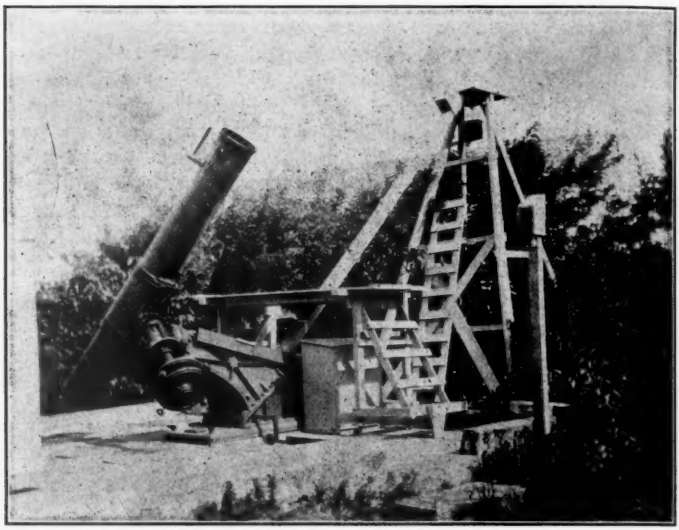
Previous to 1925, the observatory at "Woodlawn" had been the Jamaican branch of the Harvard College Observatory. It was established in 1911 by Professor Pickering, who was its Director until his retirement in 1925. The main telescope in use until that time was the excellent 11-inch Draper photo-visual refractor. This, however, was returned to Harvard in 1925, and the present reflector was purchased. Two earlier expeditions, in 1899 and 1901, to Jamaica, were made by Professor Pickering in behalf of Harvard Observatory. It was during

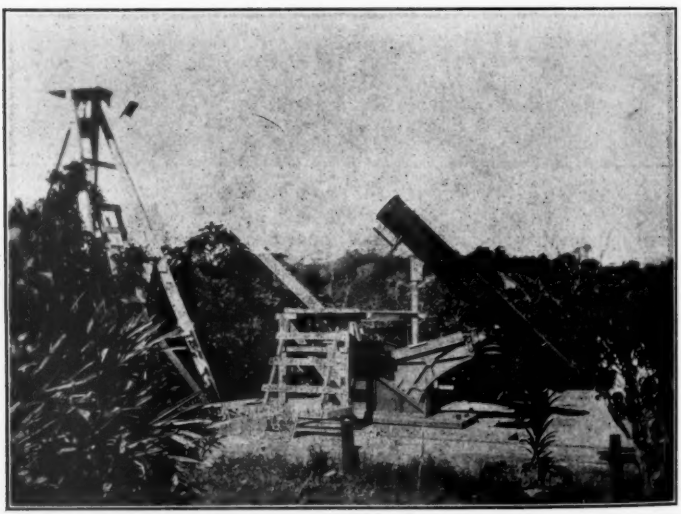
LUNAR TELESCOPE WITH 135-FOOT FOCUS AT "WOODLAWN."

the second one that the fine series of lunar photographs were made from "Woodlawn" with the 12-inch, 135-foot focus refractor, described in Pickering's book, "The Moon," and in *Harvard Observatory Annals,* Vol. 51, pt. I, and Vol. 61, pt. I. The present observatory, besides being described in POPULAR ASTRONOMY, was described in *H.A.*, Vol. 82, No. 1.

The question has probably occurred to the reader: "*Why* go all the way to Jamaica just to erect an observatory?" The first, and obvious, reason appearing is to escape the clouds of the northern anticyclone belt latitudes by going to the clear night skies of the tropics. The visibility in the tropics is wonderful due to high atmospheric transparency; also, "Woodlawn" is on a plateau at an elevation of about 2200 feet above sea level, high enough to escape much of the dust and haze of the lower

atmosphere. The West Indies were chosen, in preference to the Asiatic tropics, because of convenient transportation facilities to the United States and Cambridge. Also, Jamaica is just north of the hurricane zone





VIEWS OF PROFESSOR WILLIAM H. PICKERING'S REFLECTING TELESCOPE AND MOUNTING AT MANDEVILLE, JAMAICA, B. W. I.

and so misses most of the atmospheric disturbances. The primary reason for the choice of Jamaica, however, was the excellence there of the "astronomical seeing." It is by now well known that the success of much astronomical work, in particular the study of planetary detail, depends primarily upon the character of the local "seeing," rather than being entirely (or even primarily) a function of the size (aperture) of the telescope, and mere "transparency" of the atmosphere. Differences in "seeing" are due to differences in the conditions of the air waves and currents in front of the aperture of the telescope, and even in the tube itself, which give rise to haziness, shifting, and changing distortion of the telescopic image. This is caused by unequal and unsimultaneous refraction, by the atmospheric currents, of the light passing from different areas of the object under observation, as it passes through the disturbed atmosphere of the earth, before it reaches the observer's eye. It is very similar to the distortion of objects viewed through ripples of wavy water, with local condensations and rarefactions in the atmosphere, taking the place of the water ripples. That is, "twinkling"; greatly increasing in annoyance as the aperture of the telescope increases, and a proportionally greater area of disturbed light is taken in; very often rendering the finest and largest telescopes incapable of giving good definition, and allowing small apertures to become vastly superior for purposes of planetary, lunar, and double star observation.

The excellence of the delicate observations made for many years at "Woodlawn" rests primarily in the exquisitely good seeing conditions existing there throughout practically the entire year. It now appears that these circumstances of good seeing are due not so much to high altitude as to the high moisture content of the air, which tends to cool the atmosphere and to load it down, thus reducing the convection and other currents, and reducing the number and extent of short hot air waves which are the primary destroyers of good seeing. Thereby, the atmosphere is steadied, and the definition of fine detail is immensely improved. It also seems probable that the continual, steady blowing of the trade winds over the island, night and day, and the almost unvarying temperature at Mandeville throughout the year, are important factors in determining the excellent seeing there.

Besides the 12.5-inch Newtonian, Calver reflector, there was also available Professor Pickering's fine 3-inch, Thos. Cook and Sons refractor, which had been the gift of the widow of the late Professor George Hall Hamilton, who worked for a number of years in Jamaica with Professor Pickering. In passing, I might note my great sorrow that Professor Hamilton had died the autumn before I reached Jamaica, so that I was never to have the pleasure and stimulation of knowing and talking with that extraordinarily gifted man, whose Mars observations at Lowell Observatory and in Jamaica are well known. His excellent 12-inch and 21-inch reflecting telescopes, made by him in Mandeville with no machine shop or previous optical experience, are familiar to many,

through his two papers in the *Scientific American,* January, 1928, and May, 1929.

The 3-inch refractor and my own 6-inch, F:15 (90″ e.f.l.) Mellish reflector, which I had brought to Jamaica with me, were mounted alongside of the 12.5-inch tube, near the declination axis junction. These three telescopes rode the heavy Calver mounting perfectly, without any shake or tremor, and made an imposing, as well as very useful battery of instruments. Three finders were used, one for each instrument, though they were all in essential alignment. Some trouble was experienced at first with the slow motions, but these were soon adjusted satisfactorily. The Calver speculum had not been silvered for nearly a year, so I undertook, with some trepidation, the job of resilvering it and the flat in the difficulties of tropical heat and moisture. My largest previous experience in silvering had been with 6-inch mirrors, using the Brashear process, in the convenience of a well-equipped laboratory. None of these had turned out very well, so I expected very little from my first attempt on a 12.5-inch mirror, in the tropics, and far from the cleanliness and convenience of a laboratory. The Rochelle Salt method was used, and great emphasis was placed on the cleansing processes. I used everything available for cleaning, rinsing thoroughly with concentrated nitric acid and filtered rain water after each step. Even such things as soap suds, gasoline, alcohol, and kerosene, were used in cleaning, besides the regular nitric acid, stannous chloride, french chalk, and potassium hydroxide solutions. The temperature of the brick Delco lighting plant house, where the silvering was done, was 85° F at that time! Much trouble was expected in the chemical reactions from this unusually high temperature. However, much to our pleasure, and my surprise, the silver coats on both the 12.5-inch speculum and the 3-inch flat came out beautifully. Probably the scrupulous attempt at absolute cleanliness, and the heating of the mirrors by the hot air and warm solutions, contributed much to the good coats obtained under what I had thought would be trying conditions.

However, in writing of the silvering of the 12.5-inch mirror, I am getting a bit ahead of myself, as this was not done until after I had been observing at "Woodlawn" for several weeks. When we were talking over the observational work I was to do, Professor Pickering very kindly suggested several programs, and we discussed the techniques to be used, all of which were visual. He, however, gave me practically free rein to conduct the observational work as I saw fit, and offered the use of all the instruments available at "Woodlawn." Several nights were spent in getting accustomed to the "feel" of the telescope and mounting, and in getting the Thos. Cook and Sons filar position micrometer and the numerous eyepieces in shape for observation. The observational work I did while in Jamaica will be discussed briefly, later in this paper.

(To be continued.)

Planet Notes for September and October, 1937

Note: All times, unless otherwise stated, are Central Standard Time.

The *Sun* will be moving southeastward during this period, crossing the equator on September 23 and marking, by that event, the beginning of autumn. It will move from Leo, through Virgo, and into Libra, passing near the star Spica on October 17. The stars in these constellations will consequently not be visible during this period. On October 4 the earth will be exactly at its mean distance from the sun. The southward motion of the sun will be noticed by people living in the northern hemisphere in the marked lessening of the daytime.

The phenomena of the *Moon* will occur as follows:

New Moon	Sept.	4	at 5	P.M.
First Quarter		12	" 3	P.M.
Full Moon		20	" 6	A.M.
Last Quarter		26	" 12	P.M.
New Moon	Oct.	4	at 6	A.M.
First Quarter		12	" 10	A.M.
Full Moon		19	" 4	P.M.
Last Quarter		26	" 7	A.M.

The moon will be at perigee on September 23 and again on October 21; at apogee on September 11 and again on October 9.

Mercury at the beginning of the period will be moving westward (retrograde). It will pass the sun on September 14 (inferior conjunction). On September 30 it will be at a point of greatest elongation west. At this time it will be nearly seven degrees north of the sun and, consequently, will rise more than an hour before the sun. It will be fairly easily recognizable on and near this date on the eastern horizon just before sunrise and at a point slightly north of the point at which the sun rises. It will be of about zero magnitude. It then moves rapidly eastward and passes the sun again (superior conjunction) on October 29.

Venus will be west of the sun and moving eastward a little more rapidly than the sun throughout these two months. At the end of October it will still be more than an hour west. It will also remain from ten to twelve degrees north of the sun. These circumstances will cause it to remain a bright morning star. Its magnitude will be —3.4. On September 25 it will pass very close to Regulus, and on October 31 it will be a short distance northwest of Spica.

Mars is moving eastward more slowly than the sun and is being overtaken by it. It will, however, be in favorable position for observations in the evening throughout the period. Being more than twenty degrees south of the equator obviously makes observing conditions less favorable for northern observers. It will move from a position near Antares in Scorpius into the constellation Sagittarius. Mars will be receding from the earth and its brightness will be diminishing. It will be somewhat brighter than a star of magnitude 1.0.

Jupiter will change its position among the stars only slightly during this period. Its net motion will be between three and four degrees east and less than a degree north. It will remain near the boundary betwen Sagittarius and Capricornus, a region devoid of any conspicuously bright stars. It will be at quadrature, ninety degrees east of the sun, on October 12. Jupiter's distance from the earth will vary in light-time from 37.27 minutes to 44.10 minutes.

Saturn will be in a very favorable position for observation, being at opposition with the sun on September 25 and very nearly on the equator. This interesting object will, therefore, be frequently observed by enthusiastic amateurs. As the earth will be only a few degrees from the plane of the rings, the aspect of the rings will not be particularly striking. They will, however, be visible throughout this period as the earth remains on the same side of their plane throughout.

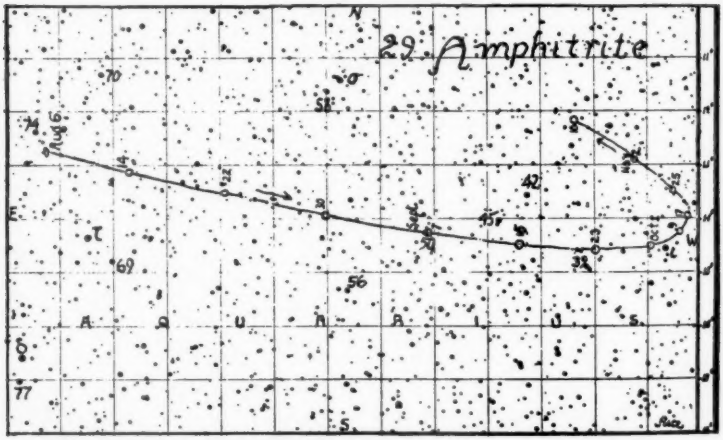
Uranus will be coming into a favorable position. It will rise soon after sunset toward the end of the period. For those who wish to use circles in looking for it, its position on October 1 will be R.A. $2^h\,42^m$, Decl. $+15°\,19'$.

Neptune will be in conjunction with the sun on September 11, and hence will be too near the sun to be seen for most of the period. Near the end of October it may be seen in the east in the early morning. Its position on October 31 will be R.A. $11^h\,26^m$, Decl. $+4°\,48'$.

Asteroid Notes

By HUGH S. RICE

One of the most favorable asteroids to be observed from August to November is 29 Amphitrite, whose apparent path among the stars in Aquarius is shown on the chart. It is of 9th magnitude at opposition on August 29. This planet was discovered at London on March 1, 1854, by Marth. It was then half a magnitude fainter than the above brightness. On the day following, it was independently found by Pogson at Oxford. At the time of discovery it was very near its eastern



stationary point, and the first elements of the orbit determined were not influenced by the customary uncertainty at opposition.

The *Astronomisches Rechen-Institut* gives an ephemeris around opposition time, and, as this ephemeris runs out in September, Meyer of Rutherford extended the ephemeris so that observers may follow the object until well into the autumn. The *R. I.* ephemeris was made using the perturbations, and Meyer's extension was effected by empirical corrections, so that it agrees with that of the *R.I.* The asteroid was observed by this computer at the last opposition and found to have

zero residuals at that time. Therefore the chances of an observer's finding it from the above chart are good.

Ceres is also at opposition in August, but as this planet is so far south (Piscis Austrinus) it is not so convenient for northern observers as Amphitrite. It is, however, of brighter magnitude, $7^{M}.8$. On August 6, Ceres is 2° north of λ Piscis Austrini; on September 7, 2° north of θ PsA; on October 9 it is at its western stationary point, $4\frac{1}{2}$° northwest of θ. It can be followed by the aid of these directions and a star atlas, such as Schurig's *Himmelsatlas* or Norton's *Star Atlas*.

The apparent path of Pallas is shown in the chart in the preceding issue of this magazine, until the second week in September, when it is moving southwardly; and then it goes into its direct motion, being 3° N of θ Serpentis Caudae on October 1. The magnitude averages 9.5 during this period. The best method of measuring distances on celestial charts is to have an atlas photographed and printed on a scale commensurable with a millimeter scale, say 40^{m} of R.A. and 10° of Decl. equal to just 20 mm. This applies to the Mercator projection, and is for the equatorial regions. The positions can be easily measured off. Circumpolar regions to conform with this are made equal to the above in declination, but the right ascension is more difficult, for a polar projection is used; but not many asteroids are found in these regions.

Juno is not in a favorable position for observation during this period.

In our chart in this issue, the positions are indicated for 7:00 P.M. E.S.T. The faintest stars of the chart are of 10th magnitude, which is below the magnitude of our other charts published in this department.

Hayden Planetarium, American Museum of Natural History,
New York, July 21, 1937.

OCCULTATION PREDICTIONS

(Taken from the *American Ephemeris*)

OCCULTATIONS VISIBLE IN LONGITUDE +72° 30′, LATITUDE +42° 30′.

Date 1937	Star	Mag.	IMMERSION Greenwich C.T.	IMMERSION *a*	IMMERSION *b*	IMMERSION Angle E from N	EMERSION Greenwich C.T.	EMERSION *a*	EMERSION *b*	EMERSION Angle E from N
			h m	m	m	°	h m	m	m	°
Sept. 1	*f* Gem	5.2	7 9.5	+0.2	+1.3	85	8 3.2	−0.2	+0.7	290
18	c^1 Cap	5.3	2 23.7	−1.6	+1.1	55	3 44.2	−1.6	+0.3	244
19	207 B.Aqr	6.4	5 49.6	−1.6	−0.9	88	6 53.0	−0.6	+0.8	213
24	54 Ari	6.5	1 16.8	+0.7	+2.4	19	1 47.0	−0.4	+0.3	308
25	53 Tau	5.4	5 8.8	−0.8	+1.4	83	6 16.8	−1.1	+1.5	252
25	247 B.Tau	5.7	9 53.3	−1.9	+1.4	51	10 55.4	−1.4	−2.4	304
26	*o* Tau	4.8	8 28.5	−1.3	+4.0	34	9 13.8	−2.1	−3.0	324
27	16 Gem	6.1	7 45.6	−1.4	+0.3	114	8 56.0	−1.5	+1.4	254
Oct. 1	14 Sex	6.3	8 15.0	..	..	185	8 29.6	..	..	214
11	128 B.Sgr	6.4	20 27.8	−2.0	+1.5	62	21 54.6	−2.2	0.0	278
12	266 B.Sgr	6.1	20 46.8	−1.8	+0.9	98	22 6.6	−1.8	+1.3	231
14	27 G.Cap	6.2	0 18.5	−1.6	+0.7	54	1 40.7	−1.6	−0.4	253
16	44 Aqr	5.8	5 10.6	−0.2	+1.3	20	5 58.3	−0.8	−2.3	285
21	π Ari	5.4	2 24.9	−2.2	−0.8	132	2 55.6	+0.3	+4.2	187
21	45 Ari	5.9	5 51.8	−1.6	+1.1	60	7 5.7	−1.8	−0.5	268
21	ρ Ari	5.6	6 23.7	..	..	145	6 49.9	..	..	185
21	54 Ari	6.5	11 53.1	−0.2	−0.7	69	12 43.6	+0.3	−1.3	280
23	ι Tau	4.7	5 31.6	−1.4	+1.3	78	6 46.4	−1.7	+0.4	272
23	105 Tau	6.0	8 9.2	−1.9	+0.9	67	9 19.0	−1.5	−1.8	297
27	α Cnc	4.3	5 7.6	+0.1	+1.3	90	6 4.0	−0.4	+0.4	298
27	κ Cnc	5.1	11 9.4	..	..	190	11 33.4	..	..	223

OCCULTATIONS VISIBLE IN LONGITUDE +91° 0′, LATITUDE +40° 0′.

Sept.	18	c^1 Cap	5.3	1	52.9	—1.3	+2.1	38	3	7.3	—2.1	+0.5	267
	18	c^2 Cap	6.2	2	33.8	—2.8	—0.2	114	3	21.8	—0.5	+2.9	186
	19	κ Aqr	5.3	3	2.6	—2.6	+0.1	109	3	52.3	—0.5	+2.9	188
	19	207 B.Aqr	6.4	5	17.2	—1.8	+0.6	67	6	34.7	—1.3	+0.7	229
	23	19 Ari	6.0	2	33.5	—0.6	+0.4	123	3	5.8	+0.4	+2.8	194
	25	53 Tau	5.4	4	56.7	—0.1	+1.7	68	5	56.1	—0.7	+1.2	266
	25	247 B.Tau	5.7	9	16.1	—1.7	+2.0	54	10	27.0	—2.1	—1.1	291
	26	o Tau	4.8	8	4.1	—0.2	+4.7	25	8	39.6	—2.3	—2.5	326
	27	16 Gem	6.1	7	25.7	—0.7	+0.8	107	8	29.2	—0.8	+1.6	256
	29	29 Cnc	5.9	10	40.2	—1.2	—1.2	144	11	41.6	—1.7	+1.8	251
Oct.	13	27 G.Cap	6.2	23	45.1	—1.6	+1.9	38	1	3.7	—2.5	—0.2	275
	16	44 Aqr	5.8	5	2.5	+0.2	+3.3	0	5	39.4	—2.4	—3.5	299
	21	π Ari	5.4	2	1.3	—0.7	+0.8	107	2	48.1	—0.1	+2.4	213
	21	45 Ari	5.9	5	21.5	—1.2	+2.1	47	6	30.8	—2.0	+0.1	273
	21	ρ Ari	5.6	5	38.0	—2.6	—1.4	125	6	23.2	—0.8	+3.8	197
	21	54 Ari	6.5	11	49.4	—0.5	—1.2	92	12	47.3	—0.2	—0.8	257
	23	ι Tau	4.7	5	9.3	—0.7	+1.8	68	6	14.8	—1.3	+0.7	277
	23	330 B.Tau	6.3	6	9.3	..	..	167	6	17.0	..	..	179
	23	105 Tau	6.0	7	33.2	—1.7	+1.4	71	8	48.7	—2.0	—0.5	284

OCCULTATIONS VISIBLE IN LONGITUDE +120° 0′, LATITUDE +36° 0′.

Sept.	15	226 B.Sgr	6.4	7	28.4	0.0	+1.1	26	8	18.6	—1.1	—2.3	291
	18	c^1 Cap	5.3	1	14.9	—0.7	+2.5	34	2	10.8	—1.1	+0.7	285
	18	c^2 Cap	6.2	1	42.8	—0.9	+1.0	101	2	41.9	—1.1	+2.4	214
	19	κ Aqr	5.3	2	16.4	—0.8	+1.3	91	3	16.6	—0.9	+2.2	219
	19	207 B.Apr	6.4	4	27.8	—1.1	+2.3	33	5	38.9	—2.2	+0.6	266
	25	53 Tau	5.4	4	59.0	+0.7	+1.7	46	5	41.6	—0.1	+0.5	291
	25	227 B.Tau	5.9	6	30.6	—0.7	0.0	126	7	8.2	+0.4	+2.7	209
	25	247 B.Tau	5.7	8	38.1	—0.2	+3.2	32	9	27.1	—2.0	—0.6	303
	26	BD+21°918	6.3	13	25.4	—2.2	+0.2	83	14	46.4	—1.8	—1.4	289
	27	16 Gem	6.1	7	17.2	+0.3	+1.0	88	8	11.0	—0.1	+1.0	272
	28	f Gem	5.2	13	36.4	—2.1	+0.6	92	14	57.4	—1.9	—1.4	304
	29	29 Cnc	5.9	10	18.2	—0.6	—1.0	148	11	1.5	—0.2	+2.6	237
Oct.	8	147 B.Lib	6.1	2	21.9	—0.4	+0.2	47	3	12.2	—1.2	—2.9	318
	12	36 Sgr	5.1	3	47.9	..	..	145	4	9.0	..	..	175
	16	51 Aqr	5.8	8	19.6	—0.9	—0.6	75	9	24.0	—0.4	+0.1	231
	21	ρ Ari	5.6	4	48.8	—0.8	+1.2	89	5	49.0	—0.7	+2.0	229
	21	45 Ari	5.9	4	59.2	+0.6	+3.7	10	5	31.4	—2.1	—0.8	309
	21	54 Ari	6.5	11	28.8	—1.5	—2.4	123	12	23.2	—1.5	+1.3	219
	22	53 Tau	5.4	14	58.8	—0.6	—0.7	78	15	54.5	0.0	—1.5	287
	23	ι Tau	4.7	4	59.8	+0.5	+2.2	43	5	42.8	—0.7	+0.2	301
	23	330 B.Tau	6.3	5	24.6	—0.6	+0.2	122	6	8.6	+0.1	+2.4	222
	23	105 Tau	6.0	6	55.9	—0.4	+2.2	54	7	55.0	—1.5	+0.2	290
	28	14 Sex	6.3	14	21.3	—1.7	—1.1	129	15	45.7	—2.0	—1.0	294

The quantities in the columns *a* and *b* are given for the purpose of making these predictions useful for any place within 200 miles of the point indicated. The procedure is as follows: Subtract the longitude of the point given from the longitude of the place in question; multiply the result, in degrees, taking the signs into account, by the quantity under *a* for the star to be observed; similarly, with the latitude, using *b*; apply the sum of the products, with its proper sign, to the Greenwich C.T., and obtain the predicted Greenwich Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to subtract five hours; Central Standard Time, six hours, etc.

Comet Notes

By G. VAN BIESBROECK

COMET 1937 *f* (FINSLER). A fairly bright unexpected comet was found in the morning sky on July 4 by Professor P. Finsler of the University of Zurich (Switzerland). The discovery was broadcast July 5 by the Central Bureau of Telegrams at Copenhagen:

1937 July 4.0026 U.T.
Right Ascension $3^h\ 6^m\ 6^s$ Declination $+38°\ 37'$
Magnitude 7. Diffuse without indication of tail.
Daily motion 48^s east and $36'$ north.

The name of Finsler is already known in comet literature for his previous discovery of another fairly bright comet 1924 II which he found while at Bonn (Germany).

The new comet was in the constellation Perseus near the variable star Algol when first seen. Numerous observations soon made it possible to predict the future course which appears promising. The following preliminary orbits have been published to date:

	Cunningham	Moeller	Maxwell I	Maxwell II
T	Aug. 14.522	Aug. 12.435	Aug. 16.574	Aug. 15.76946
ω	115°.3961	116°.598	114°.370	114°.75167
Ω	59.670	61.875	57.622	58.40894
i	147.134	148.397	145.807	146.33689
q	0.86071	0.85649	0.86435	0.8629708
Dates	July 4-6-7	July 4-5-7	July 4-6-7	July 6-10-13

They agree quite well and indicate a retrograde motion in a parabolic orbit, which will bring the comet closest to the earth in the first half of August, with an expected maximum of brightness between 3rd and 4th magnitudes. The following ephemeris is from Maxwell's second set of elements, which are evidently close to the final ones:

1937		α h m	δ ° ′	Distance from earth	Distance from sun	Mag.
July	30	4 46.7	+70 10	0.690	0.917	4.0
August	1	5 42.0	74 36			
	3	7 26.5	77 48	.605	.895	3.8
	5	9 52.1	77 14			
	7	11 38.2	72 15	.556	.878	3.6
	9	12 34.4	64 58			
	11	13 5.3	56 55	.556	.867	3.6
	13	23.9	48 54			
	15	36.1	41 23	.603	.863	3.7
	17	44.5	34 36			
	19	50.6	28 38	.688	.865	3.8
	21	55.2	23 27			
	23	13 58.6	18 57	.796	.873	4.0
	25	14 1.4	15 04			
	27	3.5	11 42	0.918	.888	4.2
	29	5.2	8 46			
	31	6.6	6 12	1.05	.908	4.4
Sept.	2	7.7	3 56			
	4	8.7	1 55	.18	.933	4.6
	6	9.5	+ 0 07			

1937		α h m	δ ° ′	Distance from earth	Distance from sun	Mag.
Sept.	8	14 10.2	— 1 30	1.31	0.962	4.8
	10	10.8	2 58			
	12	11.4	4 18	.43	0.996	5.1
	14	11.9	5 31			
	16	12.4	6 39	.56	1.03	5.3
	18	12.9	7 42			
	20	14 13.3	— 8 40	1.68	1.07	5.5

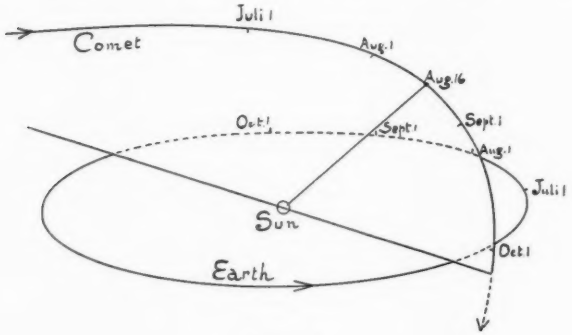


FIGURE 1
ORBIT OF COMET FINSLER RELATIVE TO THE EARTH

The magnitudes have been computed under the assumption that the brightness varies as the sixth power of the distance from the sun. Figure 1 shows the comet's motion in space relative to the earth. The two objects will be closest together

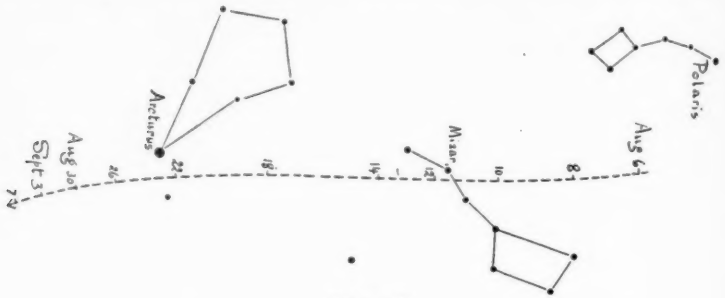


FIGURE 2
PATH OF COMET FINSLER DURING AUGUST

about August 9. Figure 2 shows the comet's course among familiar evening constellations. Passing the line from Polaris to the pointers of the Big Dipper on August 6, the comet will move from day to day toward the southwest while at maximum brightness. It will be seen near Mizar, the middle star of the handle of the Dipper, on August 11, moving toward the bright star Arcturus near which it passes August 22 and thence southward, gradually fading in brightness until it is lost in the evening sky at the end of September.

The expected increase in brightness is already confirmed. The magnitude was estimated by the writer as 7.3 on July 6; on July 15 and 19 the estimates were 5.9 and 5.6 so that the comet was already visible with the naked eye.

FIGURE 3
COMET FINSLER ON JULY 20, 1937,
as shown by a 24-minute exposure with the 24-inch
reflector of the Yerkes Observatory.

The first photographs showed that the comet had a little threadlike tail emanating from the round head which had a central bright nucleus. While the comet gained in brightness this tail has developed considerably, as shown in Figure 3, which is reproduced from a 20-minute exposure with the 24-inch reflector of the Yerkes Observatory on July 20. The length is already over a degree, and one sees the tail composed of a complex bundle of streamers coming out of the nucleus. It will be of interest to follow this structure which changes considerably from day to day. Amateurs are urged to make naked eye comparisons of the brightness of the comet compared with known neighboring stars.

COMETS 1937 *b* (WHIPPLE) and 1937 *c* (PERIODIC GRIGG-SKJELLERUP) are still

under observation in the evening sky but the latter is fading rapidly and will soon be lost. Whipple's comet passed its maximum brightness in June. The decrease resulting from the recession in distance is, however, slow. My estimate on July 18 was 9.2. It will be possible to follow the comet for some time before it is overtaken by the twilight.

PERIODIC COMET 1925 II (SCHWASSMANN-WACHMANN) has been again recorded here as an extremely faint coma during June. It is now no longer observable.

At the end of this year the short-period COMET ENCKE comes once more near to us. It is at perihelion on December 27, according to Crommelin's prediction in the *Handbook of the British Astronomical Association*, but will probably be observed several months earlier. The following abstract is from the search ephemeris given by Crommelin:

1937		α h m	δ ° ′	—Distance from— earth	sun
Aug.	27	2 17.7	25 44	1.45	2.05
	31	19.2	26 33		
Sept.	4	20.2	27 25	1.28	1.97
	8	20.6	28 19		
	12	20.4	29 16	1.11	1.88
	16	19.5	30 17		
	20	17.6	31 22	0.95	1.78
	24	14.7	32 31		
	28	2 10.3	33 46	0.80	1.69

Williams Bay, Wisconsin, July 20, 1937.

METEORS AND METEORITES

Contributions of the Society for Research on Meteorites

Edited by FREDERICK C. LEONARD,
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President of the Society: H. H. NININGER, Colorado Museum of Natural History and American Meteorite Laboratory, Denver
Secretary of the Society: ROBERT W. WEBB, Department of Geology, University of California at Los Angeles

The Report of the President of the Society for the Term 1933-37*

By FREDERICK C. LEONARD

The By-Laws of the Society (Art. II, Sec. 2) require that "The President shall prepare, at the end of his term, a written report on the history, progress, and activities of the Society during his administration. . . ." Accordingly, my duty, at the time of my egress from the presidential office, is to render you, the members of our organization, a general report for the term 1933-37, the first four years of the Society's existence. A complete record of the accomplishments of the organization, from the date of its inception to the present moment, is contained in its an-

*The concluding address delivered at the Fifth Annual Meeting, Colorado Museum of Natural History, Denver, June 22 and 23, 1937.

nouncements, NOTES, and CONTRIBUTIONS, which have appeared regularly in our official journal, POPULAR ASTRONOMY, since the April, 1933, issue, and which, commencing with the CONTRIBUTIONS for the year 1935, have been annually reprinted in fascicle form. This circumstance facilitates the making of the current report, which needs be, then, but a brief chronicle of the highlights of our progress during the past quadrennium.

The preliminary period of the Society's history dates from March 18, or even earlier, to August 21, 1933, the opening date of the First or Organization Meeting. During that formative period the now President and Secretary served as the Acting President and Secretary of the embryonic organization, which terminated at the First Annual Meeting, held auspiciously in the home of the greatest collection of meteorites in the world, the Field Museum of Natural History, in Chicago, Illinois, on August 21 and 22, 1933. At that meeting, at which no less than fifteen of the approximately fifty-five charter members were present, the original Constitution and By-Laws were adopted, the present Council was elected, three special committees and the Board of Editors (now called the Publications Board) were appointed, and several addresses and scientific papers were delivered by their authors. Dr. Oliver Cummings Farrington, who had been for many years Curator of Geology in the Field Museum and who was then the foremost authority on meteorites in America, if not in the world, was elected Honorary President for life, which continued, however, only until the following November 2. Dr. Farrington lay on his deathbed at the time of this election, which came as doubtless the final honor in his long and distinguished career. The Society has been deprived by death of several of its early members, including the Honorary President. For the loss of each of these valued *confrères,* we pause to express our sorrow.

The Second Annual Meeting occurred in conjunction with the ninety-fourth meeting of the parent body of the American Association for the Advancement of Science (Section D: Astronomy) at the University of California, Berkeley, on June 18 and 20, 1934. Although the number of members present at this meeting was small (not many of our company residing in the San Francisco Bay area), the same enthusiasm which characterized the First Meeting was apparent, and no fewer than fourteen papers and reports were delivered (seven by their authors).

The Third Annual Meeting took place in connection with the ninety-sixth meeting of the main body of the Association (Section D), at the University of Minnesota, Minneapolis, on June 26 and 27, 1935. The number of members at this meeting was even less than that at the Second and for a similar reason; nevertheless, some seven communications (the majority of which had been forwarded by absent members, one in India) were read. What this meeting, like the Second, lacked in attendance, it seems to have compensated for in scientific interest!

The Fourth Annual Meeting, held independently at the University of California at Los Angeles on June 23 and 24, 1936, was, partly on account of the presence of so many of our members in Southern California, the best attended and otherwise the largest meeting in the history of the Society up to that time. Nineteen members came, fourteen technical papers (including one from England, another from India) and two popular lectures were delivered, and an evening excursion to the Griffith Observatory and Planetarium was conducted. Ten of the fourteen papers were presented personally by their authors. At this meeting certain proposed amendments to the Constitution and the By-Laws were adopted and the Articles of Incorporation, as drawn up by the Committee on Incorporation, were approved.

Now, on June 22 and 23, 1937, we are assembled at the Colorado Museum of Natural History in Denver for our Fifth Annual Meeting—a meeting which is occurring conjointly with the one hundredth convention of the A.A.A.S. (Section D) and its Western Divisions and which has proved to be, in every way, an event worthy of the occasion.

[1]The Fifth Meeting exceeded even the Fourth one in size. Twenty-seven members attended and twenty-three papers, contributed from the United States, Australia, Czechoslovakia, England, India, and the U.S.S.R., were presented, fourteen personally by their authors. One of the most interesting and profitable features of this meeting was a joint symposium with Section E (Geology and Geography) of the Association, on the subject of meteoritic craters, in which a number of leading authorities, in both geology and meteoritics, participated. At this combined session, eight papers were delivered, five by their authors. At the Fifth Meeting also, the completely recast Constitution and By-Laws were adopted, the election of the Council for the quadrennium 1937-41 was held, a few Fellows and Patrons were elected by the Council under the revised Constitution and By-Laws, and several committee and administrative reports were made. The adjournment of this meeting, on June 23, marked the expiration of the 1933-37 term of office.

At the conclusion of the Organization Meeting, on August 22, 1933, the Society numbered about fifty-five charter members, located in some fourteen States of the United States and two other countries, namely, England and Mexico. Now, at the close of the Fifth Annual Meeting, the Society has on its roll nearly two hundred members, representing thirty-one States of the Union and ten other nations, *to wit*, Australia, Canada, Czechoslovakia, England, France, India, Mexico, Norway, the Panama Canal Zone, and the U.S.S.R. These figures show not only how our membership has increased but also how it has spread throughout the world. The Constitution (Art. I, Sec. 3) provides that "This Society, in its membership and activities, shall be an international organization." We have always stressed the international character of the Society and have cordially welcomed to membership persons in every land. Meteoritics has for its realm of investigation the universe, and for its field of exploration the earth; hence, the Society for Research on Meteorites belongs properly not to any one country but to all.

The professions of our members are as diversified as their nationalities. Because meteoritics is a hybrid science, it is not astonishing, but for that reason no less noteworthy, that the Society has on its roll meteoriticists, astronomers, geologists, chemists, physicists, mathematicians, biologists, and even linguists!

By an arrangement completed early in 1933, with the publishers of POPULAR ASTRONOMY, that periodical became the official journal of the Society and carried in the April, 1933, number (p. 216) the first public announcement of the proposed new organization, in a 14-line note entitled "The Society for Research on Meteorites." That note marked the beginning of our publications, which have appeared serially in POPULAR ASTRONOMY ever since. It was followed by several other preliminary announcements in the immediately succeeding issues and by the NOTES, which made their initial appearance in the October, 1933, number. These continued during the remainder of the year 1933 and until the end of the year 1934, when they were superseded (at least in name) by the CONTRIBUTIONS, as our publications have been known since January, 1935. The early announcements and the NOTES, dating from April, 1933, to December, 1934, and comprising 52 pages,

[1] This paragraph was inserted after the Fifth Meeting was over, to complete the report.

have, regrettably, never been reprinted. The CONTRIBUTIONS have, however, been reprinted annually, in January of the year next following that of publication, as Fascicle No. 1 for 1935 (45 pp.) and Fascicle No. 2 for 1936 (60 pp.) and have been distributed by the Secretary's office to all the members of the Society and to a great many institutions and organizations in the United States and elsewhere. The CONTRIBUTIONS which have appeared so far in the current year (*i.e.* those included in the first six numbers of POPULAR ASTRONOMY for 1937) cover 33 pages. Thus, a total of 190 pages of material has been published by the Society in the present term. This represents an aggregate of 57 full-length papers and 48 notes and abstracts. Unfortunately, lack of space and the condition that this is intended to—and must needs—be largely an administrative report, prevent not only a review of the results contained in, but even a mention of any of these numerous research papers, some of which have been of great scientific value. Both the NOTES and the CONTRIBUTIONS OF THE SOCIETY have been edited by the President and the Secretary (in accordance with the Constitution, Art. V, Sec. 3), from the President's office. The Publications Board, under whose charge the publications are issued, has consisted of the President and the Secretary, *ex officiis*, and two additional members whom they appointed at the Organization Meeting, namely, the First Vice-President and the Editor of POPULAR ASTRONOMY (Constitution, Art. V, Sec. 2).

On the subject of publications it should be added that, mainly through the generous aid of one of our members, the Society succeeded in acquiring, in 1934, from Mrs. O. C. Farrington, all the remaining stock (more than four hundred copies) of the late Dr. Farrington's classical treatise on *Meteorites* (x + 233 pp.: published by the author in 1915). As a result of that transaction, copies of this indispensable work have since been on sale by and obtainable from the Secretary-Treasurer's office.

In all, thirteen special committees have been appointed in the course of this term, namely, the Committees on (1) Terminology; (2) Exhibits; (3) Questionnaires; (4) Classification; (5) Discovery, Identification, and Analysis; (6) Relations between Meteors and Meteorites; (7) Collections; (8) Meteoritic Features of the Earth's Surface; (9) the Advisory Committee for the Proposed Meteoritical Institute; the Committees on (10) Incorporation; (11) Membership; (12) Endowment; and, finally, (13) the Nominating Committee for the quadrennial election held at this (the Fifth) Meeting. Each of these committees has been named either by the President or by the Executive Committee of the Council. As previously stated, the first three committees were formed at the Organization Meeting; the others have been established more recently and in the order enumerated. The Committee on Incorporation and the Nominating Committee, having served their purpose, have already been discharged; the remainder, like all such appointments, will, under the By-Laws (Art. VI), automatically lapse at the end of this term (*i.e.* at the adjournment of this meeting), unless they are reappointed by the succeeding administration.

As already remarked, the First Vice-President and the Editor of POPULAR ASTRONOMY, our official organ, were chosen by the President and the Secretary, at the Organization Meeting, to serve with them on the Publications Board during the term now concluding.

Other appointments which have been made and which should be recorded here are those of the Assistant to the Secretary (or the Assistant Secretary), a position created and filled early in the year 1934, and the Official Delegate to the Seventh American Scientific Congress in Mexico City, Mexico, from September 8 to 17,

1935. Our delegate read a paper (since published in abstract form in the CONTRIBUTIONS) at the Section for Mathematics and Physics of the Congress, and reported that this was the only communication on a meteoritical subject to be presented before the Congress. The first of these appointments was made by the Executive Committee of the Council and the second by the President.

With the help of the Secretary, the Society has supplied two exhibits: one, composed of specimens as well as photographs and literature, to the ninety-fifth meeting of the A.A.A.S. in Pittsburgh, Pennsylvania, December 27, 1934, to January 2, 1935; the other, consisting of photographs and literature only, to the Exposition Internationale (Palais de la Découverte, Section d'Astronomie), Paris, France, 1937. Both of these exhibits attracted wide attention, the second causing several professional European scientists to join our organization.

Two outstanding administrative events in the development of the Society have been its recognition by the American Association for the Advancement of Science in 1935 and its incorporation in 1936. In April, 1935, when it was less than two years old, the Society was accepted as an associated organization by the A.A.A.S., and on July 27, 1936, it was incorporated, under the laws of the State of California, as a non-profit corporation of world-wide scope. By the former act the Society gained immensely in prestige, its official relation to the A.A.A.S. giving it a place among the scientific bodies of America which it could not otherwise possess, while by the latter it became a permanent legal entity.

It will be noted that the Society held its Second Annual Meeting concurrently with a meeting of the Association *before* its alliance with the latter had been consummated. It did so, of course, solely through the courtesy and as a guest of the Association. Since it has been granted association status, however, it has met twice with the Association in its own right as an accredited society; not only on the present occasion but also on the occasion of the Third Annual Meeting in 1935. Doubtless many of our future meetings, as was suggested in the opening address at the Organization Meeting in 1933,[2] are destined to be held in conjunction with meetings of the Association.

In conclusion, I wish to thank my fellow officers and Councilors, the members of the various committees and all other appointees, and the members of the Society at large, for their splendid coöperation in making possible whatever measure of success the Society may have attained in these first four years of its history; and finally I want to express the hope that as time goes on our organization may go forward with ever increasing zeal in the realization of those objects for which it has been established.

[2] "The Purpose and Aims of the Society for Research on Meteorites," *P.A.*, **41**, 432-6, 1933.

The Composition of Meteoritic Iron Sulphide*

By JOHN DAVIS BUDDHUE

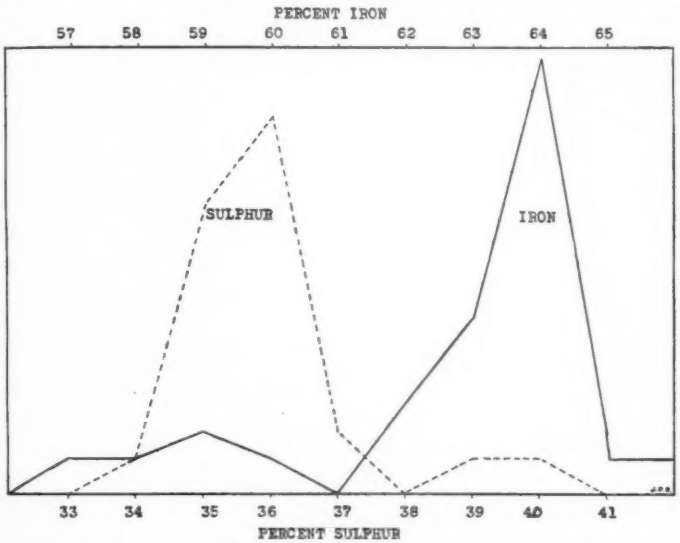
The earliest mention of an iron sulphide in meteorites seems to have been made by the Jesuit, Dominico Troili, who found it in the Albareto, Italy, (stone) meteorite in 1766. It appears to have been first regarded as pyrite, but later it was found to be more easily decomposed by acids than pyrite, and was accordingly regarded as pyrrhotite. Still later it was found that it differed more or less from

*Read at the Fifth Annual Meeting.

[1] *Sitzb. Wien Akad.*, **47**, II, 287, 1863.

terrestrial pyrrhotite, especially in that it contained less sulphur, and for this reason W. Haidinger[1] proposed that it be called *troilite*. Since then it has become clear that, although troilite has the composition FeS, and pyrrhotite varies from Fe_6S_8 to $Fe_{16}S_{17}$, they are really the same mineral, except that the pyrrhotite contains free sulphur in solid solution. Moreover, it was supposed that the meteoritic sulphide contained little or no dissolved sulphur because of the superabundance of free iron; in fact, some analyses indicate that some iron may be in solid solution.

The earliest analyses of the sulphide seem to have been made on material derived from siderites, but the measurements of G. Rose on sulphide crystals from the Juvinas, France, aërolite indicated that the material was pyrrhotite. Conse-



A Graph of the Percentages of Iron and Sulphur in Meteoritic Iron Sulphide

quently, it was thought that the sulphide in siderites was troilite, while that in aërolites was pyrrhotite. Much the same confusion seems still to exist, as a survey of the literature will show that both of the terms *troilite* and *pyrrhotite* are still used, and that calculations are sometimes based on FeS and sometimes on Fe_7S_8. Moreover, the authors report the sulphide as magnetic at times, and nonmagnetic at others; some report a deposit of free sulphur even when the sulphide is dissolved in acids, a behavior characteristic of pyrrhotite.

In order to discover whether pyrrhotite as distinguished from troilite occurs in meteorites, and, if so, to gain some idea of its frequency, I collected from various sources a list of 31 analyses of the sulphide from meteorites. From this I drew the frequency polygons of the various percentages of iron and sulphur. The ordinate is the same for both graphs, and is an arbitrary scale of frequency. Now if the variations in the analyses are those of a single substance, there should be only one maximum, but if two substances are involved there should be two maxima, unless the compositions are very similar, or if one is very rare. It will be seen from the figure that there are two well separated maxima in both frequency

polygons. The principal peaks correspond almost exactly to the theoretical values for FeS, although the sulphur shows a strong tendency to be smaller than the requirements of theory. The secondary maximum of the iron polygon indicates the presence of a sulphide whose composition is in the neighborhood of $Fe_{11}S_{12}$. The secondary maximum of the sulphur polygon corresponds to a smaller quantity of sulphur, namely Fe_9S_{10}, probably because of the extension to the left of the secondary maximum of the iron polygon. Contrary to expectations, the sulphides whose analyses are responsible for these secondary maxima came predominantly from iron meteorites.

The number of available analyses is perhaps too small to permit a definite assertion that pyrrhotite occurs in meteorites, in spite of the expectation that it would not, but they do *suggest* that such is the case. I calculate, from the available data, that 7% to 8% of the meteoritic iron sulphides may be pyrrhotite whose composition is perhaps $Fe_{10}S_{11}$, but that the remainder are definitely troilite of composition FeS, or, if anything, that there is a slight excess of iron. I do not use the name *troilite* as that of a definite mineral compound, but as a convenient term for the end member of a series of solid solutions.

Nickel and cobalt do not seem to have been determined very frequently, but such determinations as have been made give as a rule very low values. In only two analyses do the combined percentages exceed 3%. Adding these elements to the iron changes the shape of the polygon somewhat, but does not alter the conclusions. Moreover, it should be remembered that millerite (NiS) has been reported in meteorites[2] and J. L. Smith[3] has found evidence that an undetermined cobalt mineral may be present in meteoritic iron sulphides.

[2] W. E. Ford, *Dana's Textbook of Mineralogy*, p. 427, 1932.
[3] *Am. Jour. Sci.*, Ser. 3, **27**, 409, 1884.

99 South Raymond Avenue, Pasadena, California

Election of Fellows and Patrons at the Fifth Annual Meeting

Under the revised Constitution and By-Laws, adopted by the Society at its Fifth Annual Meeting, held at the Colorado Museum of Natural History in Denver, on June 22 and 23, 1937, the outgoing Council, in session on the morning of June 23, elected Dr. Robert W. Webb of the University of California at Los Angeles, then the Secretary-elect, and Dr. Curvin H. Gingrich, Editor of POPULAR ASTRONOMY, the official journal of the Society, as Fellows; and Mr. Nathan Schwartz of Los Angeles, California, and Mr. Dean M. Gillespie of Denver, Colorado, as Patrons of the Society.

Election of the Council and Appointment of the Publications Board for the Quadrennium 1937-41

At the opening session of the Fifth Annual Meeting of the Society on the morning of June 22, 1937, the Council for the quadrennium 1937-41 was elected as follows:

Officers:

President: Dr. H. H. Nininger, Colorado Museum of Natural History and American Meteorite Laboratory, Denver.

First Vice-President: Dr. C. C. Wylie, University of Iowa, Iowa City.

Second Vice-President: Dr. W. F. Foshag, United States National Museum, Washington, D. C.

Secretary: Dr. Robert W. Webb, University of California at Los Angeles.

Treasurer: Mr. L. F. Brady, Mesa Ranch School, Mesa, and Museum of Northern Arizona, Flagstaff.

Councilors:

Dr. G. M. Butler, University of Arizona, Tucson.
Professor Raymond E. Crilley, Iowa Wesleyan College, Mt. Pleasant.
Dr. Frederick C. Leonard, University of California at Los Angeles (Councilor *ex officio* as Ex-President).
Dr. F. R. Moulton, 327 South La Salle Street, Chicago, Illinois, and Smithsonian Institution Building, Washington, D. C.
Mr. Henry W. Nichols, Field Museum of Natural History, Chicago, Illinois.
Dr. Walter T. Whitney, Pomona College, Claremont, California.

The foregoing Council took office at the adjournment of the Fifth Annual Meeting on the afternoon of June 23. Immediately thereafter a special meeting of the new Council was held, at which the President and the Secretary, in accordance with Article V of the Constitution, named Dr. Frederick C. Leonard of the University of California at Los Angeles and Dr. Curvin H. Gingrich of Carleton College, Northfield, Minnesota, to serve with them on the Publications Board, and, with the concurrence of the Council, appointed Dr. Leonard as Editor of the publications of the Society.

VARIABLE STARS

Variable Star Notes from the American Association of Variable Star Observers

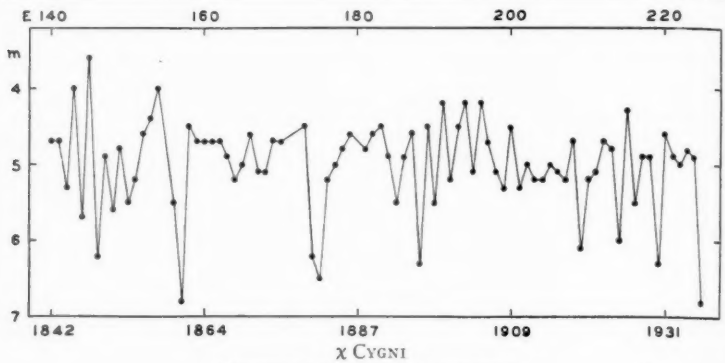
By LEON CAMPBELL, Recorder

Faint Maximum of χ Cygni: The recent maximum of χ Cygni (May, 1937) proved to be an abnormally faint one, attaining the mean magnitude of 6.8 only. The observations are sufficiently numerous and accordant at this phase to warrant this conclusion. Although no observations between magnitudes 13.0 and 10.0 were obtained on this increase to maximum, the rise from magnitude 10.7 appears to be not too rapid and there is little, if any, indication of a so-called "still-stand," such as has been noted on many previous occasions, especially when the variable has attained an exceedingly bright maximum.

The mean maximum magnitude of χ Cygni as observed over an interval of two hundred and fifty years (1687 to 1937) is 5.08, with extremes between 3.6 and 6.8, the brightest maximum having been reached in 1848 and the faintest in 1861 and 1937. Of the two hundred and twenty-five possible maxima through which the star has passed since its discovery in 1686 by Kirch, there are one hundred and six maxima observed for which fairly reliable maximum magnitudes can be deduced and the continuity since 1842 has been almost unbroken.

There appears to be no regularity in the occurrence of bright and faint maxima, respectively, although on occasions an exceptionally bright maximum is closely followed by a decidedly faint maximum. The greatest change in the heights of consecutive maxima occurred in 1848 and 1849, when the respective values were 3.6 and 6.2. The second largest difference occurred between the maxima of 1861 and 1862, when a value of 6.8 was followed by one of 4.5.

It is quite possible that the varying heights to which many "Me" long-period



χ CYGNI
OBSERVED MAXIMUM MAGNITUDES
1842-1937

variables attain may be due in great part to the impetus given the increased light just after the star has passed through a minimum. As a rule, the brightest maxima are more sharply defined than the less brilliant maxima, which are usually flatter and more rounded. A general attack on the problem of the varying heights of maxima in long-period varibles is under way at the A.A.V.S.O. headquarters.

The Presentation of Nova Medal: The David B. Pickering Nova Medal, awarded by the American Association of Variable Star Observers, for the original discovery of Nova Lacertae, on June 18, 1936, was presented to Kazuaki Gomi, of Naganoken, Japan, at the American Embassy in Tokyo, by Ambassador Grew, on May 17, 1937.

This makes the second award of this gold medal for the visual discovery of a nova, the first having been presented to J. P. M. Prentice, of Stowmarket, England, in June, 1935, for the discovery of Nova Herculis, on December 13, 1934.

Beyer Light Curves of Variable Stars: A recent reprint by Max Beyer, of Hamburg, Germany, contains observations and discussions of 55 variable stars. Among these are a number of variables for which authoritative data have heretofore been considered insufficient. Beyer has divided the stars into ten classes, including those of the Mira type with short periods; Long Periods, with small ranges; RV Tauri; Semi-regular; Irregular among the red, yellow, and white variables; R Coronae Borealis; Zeta Geminorum; and those stars of doubtful character which remain for long intervals of time at a constant magnitude and then suddenly decrease or increase in brightness.

The majority of the stars studied by Beyer are common to Nijland's list of stars which require special attention.

TZ Cephei, 001973, a circumpolar, M0 star of small range, has a period of $83^d.0$, according to Beyer, and $83^d.3$, according to Hassenstein. Beyer's use of an additional term, $-0^d.022 \times E^2$, is not borne out by a rediscussion of the original data by the Recorder. A linear period of $83^d.6$ would appear to satisfy the observations of Beyer. A mean light curve determined from the observations indicates a mean range between magnitudes 9.5 and 10.6 with maximum and minimum of nearly equal form, and the rise to maximum only slightly more rapid than the decrease to minimum. Some thirty-four epochs were covered by the observations of Beyer.

Among the long periods, with small range—mostly of the N type spectrum—Beyer supplies periods for stars which previously were considered irregular: VX Andromedae, period 367^d; UV Aquilae, 355^d; RU Coronae Borealis, 436^d; and RY Monocerotis, 466^d.

DY Aquilae, with a period of 131^d, is confirmed by Beyer as belonging to the RV Tauri type, in which there is an alternation of principal and secondary minima with occasional reversal of the order of occurrence. TX Tauri, hitherto considered an RR Lyrae type variable, is now classed as of the RV Tauri type, with a double period of 84^d.

Among the semi-regular variables, with characteristics similar to those of R Scuti, Beyer finds that TY Andromedae has a period of 249^d, as against 151^d and 141^d as derived by earlier observers. UX Andromedae has a period of 393^d, period previously unknown.

RV Aurigae, period 229^d, is now considered by Beyer as of the semi-regular type, hitherto classified as irregular and no period determined. With a spectrum of N type, the suggestion is here offered that this star should be classed with other N type variables of long period, having small range. For TV Aurigae, period previously assigned as 372^d, Beyer gives a period of half that amount, namely 182^d. The spectral type is S, of which there are relatively few known. AI Aurigae has a period of $63^d.9$; T Equulei, $147^d.5$; and SV Pegasi, 338^d; all previously of unknown period and class.

A remarkable change in period, according to Beyer, has taken place in the case of WW Tauri. During the years 1927-30, he derived a value of $113^d.6$, while for the years 1931-35, he finds that the period $138^d.3$ better satisfies these observations. This is a decidedly large change and additional observations are required to confirm such an increase in period.

Beyer has very diligently followed the light variations of the irregular variables including the exceedingly red, yellow, and white stars, besides those of the so-called R Coronae Borealis type. An examination of his plotted curves reveals some interesting forms of variation and only with long continued observations can one arrive at final conclusions as to the proper classifications. Some of the light curves closely resemble those of T Orionis and RR Tauri—not considered as of the R Coronae Borealis type by the latest criteria—while others appear to vary irregularly, apparently without rhyme or reason. To the interested variable star student, a perusal of Beyer's paper is strongly recommended.

Magnitudes of Current Novae: Observations received to date indicate the recently-discovered novae as of the following magnitudes: Nova Herculis, 180445, $8^M.3$; Nova Aquilae, 191201, $11^M.0$; Nova Lacertae, 221255, $10^M.5$. Nova Herculis is decreasing very slowly in brightness; at the rate of about a third of a magnitude in one hundred days. The fading away of Nova Aquilae No. 5 and Nova Lacertae has been far more rapid. Little is known at present of the present stage of brightness of Nova Aquilae No. 6 and of Nova Sagittarii No. 16, discovered in 1936.

Observers and Observations: During May and June the following observers contributed to the files of the A.A.V.S.O. for the first time: Miss Carolyn Alexander, of St. Louis, Missouri; Messrs. Leonard J. Ashby, of Kalamazoo, Michigan, and Cyrus F. Fernald, of Wilton, Maine; Miss Ruth J. Northcott, of Toronto, Canada; Messrs. Christopher H. Phillips, of Avon Old Farms, Connecticut, J. M. Shafer, of Jefferson City, Missouri, and Bertram J. Topham, of West Toronto, Canada.

The number of observations and names of contributors during May and June are listed below:

Name	May Vars.	May Obs.	June Vars.	June Obs.	Name	May Vars.	May Obs.	June Vars.	June Obs
Ahnert	40	248	..	..	Knott	2	2	5	5
Alexander,Miss	1	1	1	1	de Kock	50	189	50	167
Ashby	3	7	5	12	Koons	..	..	13	16
Baldwin	93	227	110	241	Kotsakis	9	44	25	27
Ballh'ssen,Miss	7	7	12	16	Kozawa	18	54	..	..
Bappu	31	166	32	69	La Fon	14	14	..	..
Blunck	17	22	21	32	Lizarraga	3	3	..	..
Bouton	52	89	48	70	Loreta	106	257	92	210
Brown, S. C.	20	20	..	..	MacCalla	2	2	2	2
Buckstaff	5	11	8	13	McLeod	18	26	23	61
Callum	27	34	22	27	McNabb	3	13	3	14
Cameron	8	15	3	3	Meek	69	322	68	150
Carpenter	240	240	251	251	Millard	29	42	29	58
Chartier	35	47	42	75	Murphy	13	44	7	25
Cousins	10	30	12	86	Northcott,Miss	1	2	1	5
Crout	..	..	6	6	Peck	14	33	..	..
Dafter, Mrs.	7	10	8	20	Peltier	..	..	162	196
Dalton	..	..	4	4	Peters	..	..	3	12
Diedrich	1	4	2	8	Phillips	1	2	..	..
Ellis	18	18	29	53	Purdy	5	5	..	..
Ensor	58	179	60	171	Rosebrugh	32	85	26	68
Escalante	..	..	14	15	de Roy	13	53	11	58
Fairbanks	..	..	6	8	Russell, J.	18	59	15	43
Fernald	..	..	2	11	Ryder	..	..	4	4
Fleischer	3	5	7	10	Schattle	2	27	..	..
Focas	59	94	..	..	Seely	..	..	2	3
Franklin	24	36	17	27	Segers	3	48	6	20
Gregory	106	122	76	111	Shafer	..	..	2	2
Hamilton	4	5	..	..	Shinkfield	16	21	15	26
Hartmann	116	227	118	277	Shultz, Miss	10	10	19	19
Herbig	52	106	..	..	Sill	46	46	25	25
Hiett	21	37	20	40	Smith, F. P.	25	38	25	36
Hildom, A.	27	42	16	21	Smith, F. W.	3	4	1	3
Holmes, Mrs.	1	1	..	..	Smith, J. R.	12	12	14	15
Holt	30	33	34	49	Smith, L.	16	16	1	1
Houghton	64	189	64	153	Starr	..	..	13	13
Houston	48	116	105	425	Thorne	7	7	..	..
Howarth	16	16	9	9	Topham	4	6	4	7
Humbert	4	5	8	16	Treadwell	9	31	7	20
Jones	103	359	78	239	Watson	..	..	21	44
Kempinski	..	..	3	3	Webb	35	41	24	31
King	8	8	..	..	Woods	..	..	24	68
Kirkpatrick	37	335	..	..	Yamasaki	15	15	14	21
Kitchens	7	8	12	20		87	4692		4066

July 17, 1937.

Notes from Amateurs

The Amateur Astronomical Society of Los Angeles

The Amateur Astronomical Society of Los Angeles went on an observing expedition to Receda, California, on the evening of Saturday, July 10. About forty members and their friends were present, many with their portable telescopes. There were two 10-inch, four 6-inch, and one 4-inch reflectors, and a 2-inch re-

fractor being used. An indication of the clarity of the atmosphere was that a star of magnitude 14.8 in the field of Nova Herculis could be seen with a 6-inch mirror. Considerable fine detail was seen on Jupiter with Mr. J. H. McCornack's fine 10-inch reflector, including the red spot, and many minute irregularities in the belts. The observing was interrupted by refreshments, after which the "seeing" went on until after midnight, when the gathering broke up.

2606 W. 8th Street, Los Angeles, California. GEORGE HERBIG.

Amateur Astronomical Society of New Haven

Enthusiastic interest continues to be manifested in the meetings and activities of the Amateur Astronomical Society of New Haven. At the May 24 meeting Mrs. Partridge gave a detailed explanation augmented by an elaborate drawing of a "Lunar Appulse" by means of which the mechanics of the appulse were clearly shown; the explanation was appreciated by all as at 1:41 A.M. the same night, May 24, an appulse took place with its maximum shadow at 3:51 A.M.

The Meteor Observing Group reported having been out three times but with the bright moon on one occasion and bad weather conditions on two other nights little was really accomplished although two extremely bright meteors were observed about 4:00 A.M. on May 2, which repaid the party for all the time spent.

Dr. Schlesinger of the Yale Observatory addressed the Society on "Observatories in South Africa." He informed the group that when Yale Observatory was reorganized in 1920 the new plans included a large photographic refractor to be erected in the southern hemisphere. After some difficulties, glasses suitable for a 26-inch telescope were secured from the Schott Company in Jena. The optical work was performed by the late James McDowell of Pittsburg, and it is the last large glass to be figured by the great optician. As suitable arrangements could not be made for having the mounting made by any of the well-known manufacturers, the Observatory decided to build the mounting itself and for this purpose erected a temporary shop on the grounds of the Observatory. After the mounting was made it was completely set up in one of the Yale buildings and was ready to ship at the end of 1924. Many sites south of the equator were considered, among them Australia, New Zealand, and South Africa. After making the requisite tests and considering all the requirements, the South African Veldt, extending from Kimberley to Pretoria, was decided upon, and many invitations were received to locate at various points on the Veldt. The Observatory is actually located in the center of Johannesburg at a height of 5700 feet where the climatic conditions are from all points of view unusually good.

At the present time there are seven large observatories in South Africa, as follows:

Cape Observatory, established 1820, Cape Town, 24-inch photographic refractor.

Union Observatory, 1903, Johannesburg, 26.5-inch visual refractor installed in 1925.

Yale Telescope, 1925, Johannesburg, 26-inch photographic refractor.

Lamont-Hussey Observatory (Michigan), 1928, Bloemfontein, 27-inch visual refractor.

Harvard Observatory, 1929, near Bloemfontein, 60-inch reflector, and 24-inch camera of 3.4 meters focus.

Leiden Observatory, 1936, Johannesburg, two 16-inch cameras of 2 meters focus.

Oxford Observatory, 1937, Pretoria, 74-inch reflector.

Dr. Schlesinger's talk was given in a pleasing, interesting manner and much appreciated by all. At the next meeting the subject will be "A Flight Through Space," to be given by the secretary.

F. R. BURNHAM, Secretary.

Amateur Astronomical Society of New Haven

The last monthly meeting until Fall of the New Haven Amateur Astronomical Society was held on June 19.

Miss Upton related many strikingly similar facts and conditions in connection with the sun's eclipse in 1883 and the recent eclipse of June 8. In the former expedition her father, Winslow Upton, was meteorologist. He sailed on the *S. S. Hartford,* flagship of Admiral Farragut, to Caroline Island a very small coral island in the Pacific 2200 miles from Honolulu. She compared the notes of his observations with those of the recent June 8 eclipse expedition on the somewhat smaller Canton Island. Many of the recorded observations and personal experiences were remarkably similar.

The Program Committee announced a rather ambitious summer program including a meeting with the New York Amateur Society on July 4 at the Norwalk Airport for an all night gathering for general study and observation, later a trip to Springfield, Vermont, one to the Van Vleck Observatory in Middletown, Connecticut, two meteor observing parties and a basket picnic with observing in the evening.

"A Trip Through Space" was the subject of a talk given by F. R. Burnham which, together with about fifty slides, briefly touched upon and emphasized some of the high points in astronomy. Beginning with the making of the first telescope in 1608 by Lippershey and its practical application to astronomy by Galileo, he followed through the peculiarity of gravitational pull of the moon, the constant and continual consumption and loss of weight on the sun by radiation of heat and light, numerous points of interest regarding the planets, star clusters, and nebulae, calling particular attention to the vastness of space and the inconceivable distances between celestial bodies, using several familiar scales and examples for comparison, and closed by quoting Flammarion who said, "We are merely a speck of dust passing in a ray of light."

The next meeting of the Society will be on September 18.

New Haven, Connecticut. D. S. KIMBALL, President.

Mars Observed by an Amateur

This spring, the writer made his first serious study of the planet Mars, with his recently completed home-built reflecting telescope of 7-inch aperture, and thought that other amateurs, who have also been studying Mars, might like to compare their notes with his.

I made 25 or 30 drawings of the planet a sseen in the 7-inch reflector during May, June, and July; and occasionally observed it with an 8-inch reflector and an 8-inch refractor, which, however, were not mine.

With only fair seeing conditions here in Iowa on the average, I found it wise to diaphragm the 7-inch reflector to 4 or 5 inches aperture.

The power used was nearly always 236×.

Although the south polar cap was turned away from the earth during this period, a white area was seen near the south pole. This white area was also seen

by Mr. W. H. Haas, of Ohio, who suggested that it may be "deserts bright either with snow or with cloud."

The *maria* seemed to be of a bluish-gray color, no prominent *changes* in color being seen. Neither the *maria* nor the "deserts" were of a uniform color at all times. This applies to *shade* or tone, also. This does not mean that *changes* were seen; but that, for example, an area need not be of the same shade as one next to it.

Strangely enough, Solis Lacus was not seen well at this opposition. Syrtis Major was darker at its tip and edges.

Only one or two "canals" were seen, one unknown, the other possibly Casius; both seen through the 8-inch refractor.

On June 26, a very beautiful sky-blue color was seen near the north polar regions near longitude 300°.

One other important feature should be made mention of, that being a very curious white rift running vertically (north-south) through the southern *maria* near longitude 50°.

The writer realizes that all the above notes are meager, and will be of not much use for the professional, but may be of some use to the amateur as mentioned before. In fact, I would be very glad to hear from any amateur student of Mars—or Jupiter, and to compare notes with him.

HUGH M. JOHNSON.
3207 Cornell Street, Des Moines, Iowa, July 17, 1937.

Amateur Telescope Making in Australia

Mr. George Petersen of Makay, North Queensland, Australia, has recently completed two 6-inch mirrors nad mountings for them. He plans to begin an 8-inch mirror in the near future. Mr. Petersen received his inspiration and instruction from "Amateur Telescope Making" which has started so many amateur astronomers, the world over, in the construction of home-made instruments. Mr. Petersen and many others are to be congratulated upon the perseverance and ingenuity displayed in this work or, possibly better, this hobby.

The Zenith Prism in Variable Star Work

The zenith prism as an accessory to the refracting telescope offers several advantages to the observer of variable stars which he would do well to consider.

First is the matter of comfort in observing. Without the zenith prism, the neck and head are often held in strained and unnatural positions which are very tiring if not actually painful. To attempt a study of the region of the zenith without such a device will leave a man feeling as though he had been through a wrestling match. With the diagonal, however, the head is always held in the natural way with no strain on the muscles of the neck, thus enabling the observer to concentrate on the work at hand in perfect ease and comfort.

Second, the area of the sky where the faintest stars may be seen (in the vicinity of the zenith) is neglected by the average amateur who uses the straight tube, owing to the difficulties of observation, but may be readily studied with the diagonal.

Third, a more accurate estimate of a variable is possible when using the zenith prism, because the latter may be rotated to bring the variable and any desired comparison star into such a position that a line connecting them is parallel with a line connecting the eyes. This is the only correct position for accurate

estimating as Argelander pointed out long ago, and which practical observers have verified or discovered for themselves.

It should be remembered that when using the diagonal the chart must always be held face down, and read through the back by a light held under it. Sometimes the chart will be held with the south at the top, and at other times with the north above, but never with the front of the chart toward the eye.

An objection sometimes advanced against the zenith prism is that position angles can not be determined with it. Conceding the truth of this objection we reply that the variable star observer has no use whatever for position angles anyway. However, it is the work of only a moment to switch to the straight tube if it ever seems desirable.

The straight tube devotee will tell you that the zenith prism causes "loss of valuable light." "Trust him not; he is fooling thee" or himself. Actual comparison with the straight tube will show anyone that the difference, if any, is too small to be detected in practical work. A much more important factor in the detecting of faint stars is the absence of muscular and nervous strain in the observer due to awkward observing positions, and the zenith prism eliminates this evil completely.

Rotating the diagonal through 180 degrees will give any orientation of the field necessary for correct estimating. It is either that or twist your neck; and who wants to rotate his head through 180 degrees?

3908 Council Crest Drive, Portland, Oregon. ROBERT E. MILLARD.

Communications and Comments

Under this heading we shall publish from time to time such material as does not properly fall under any of the established headings of this journal. Here, too, may be found, when occasion arises, articles which the editors may not be willing to give sanction to but which, nevertheless, may be provocative of thought along new lines.

Hypothesis of Accelerating Light Corpuscles*

An attempt to account for the phenomenon of the "red-shift," by means other than the theory of the "Expanding Universe."

Abstract: Ever since the Abbe Georges Lemaitre, a Belgian astronomer, and others attempted to account for the cause of the observed red-shift phenomenon in the spectrum of the outer galaxies by the so-called "Theory of the Expanding Universe," there has always, in spite of apparent evidence favoring the theory, been present in the minds of the more analytically inclined astronomers considerable skepticism concerning its actual validity. The more critically the theory was examined the more incredible appeared the picture.

Various proofs or reasons have from time to time been offered to show the improbability of such conditions as are postulated by an actual "expanding universe" really existing, but, as yet there have been few counter-theories presented attempting to account for the phenomenon in any other more rational or plausible manner. In the present hypothesis, which I have chosen to call the "Hypothesis

*A paper presented in abstract before the members of the Joliet (Illinois) Astronomical Society, at their regular meeting held Tuesday evening, January 5, 1937.

of Accelerating Light Corpuscles," I shall attempt to set forth such a counter-theory.

To begin with, we shall discard for the time being the Huygen's "Ether Wave Theory of Light Transmission," and for our purpose assume the validity of the earlier "Corpuscular Theory" as promulgated by Newton and his predecessors. This theory postulates light, instead of being the result of wave motion in a hypothetical, all-pervading ether, to be a product of exceedingly small particles of matter called "corpuscules," (photons) which are constantly being ejected or shot off radially from all luminous bodies.

The sensation of light, under the Newtonian theory, is explained as the result of stimulation to the optic nerve brought about by its bombardment by corpuscles, and the phenomenon of color is related to their mass, intensity, and/or frequency. There is no established law of nature which would prohibit us from assuming that these light corpuscles might not also be charging through space in rhythmic or wave-like motion, not unlike waves of sound or eddying waters.

These corpuscles, themselves being a form of matter are likewise presumed to obey the laws of moving bodies; that is, they will continue to travel in straight lines and at uniform speed, until or unless they are acted upon by extraneous forces, such as the gravitational pull of some outside body or mass, or a combination of such bodies under whose influence they may come.

If, therefore, according to Einstein's theory, it is possible for them to be attracted laterally out of their straight path by the gravitational pull of some larger body (star) past which they may closely flow, it would then necessarily follow that they must likewise be pulled forward by any large gravitational mass towards which they are directly headed, and in like manner retarded by such gravitational mass as may lie behind them, these forces acting ever in accordance with the firmly established laws of gravitation.

Again, should it ever be satisfactorily proven that light corpuscles can be pulled or bent out of their straight line by extraneous gravitational forces, then we have no other alternative than to assume that they will also obey the proven laws of falling bodies, and that their motion will become accelerated as they approach large gravitational masses and retarded as they recede. If a single star should possess the ability to bend light, should not the gravitational mass of entire galaxies exercise an infinitely greater pull, with its consequent greater acceleration?

Whatever value this acceleration may eventually prove to be, must it not also be additive to any initial velocity which this light must have acquired as it was shot outward from its original source? Moreover, whatever and wherever may have been its source we must, by the very nature of things, assume the value of this initial velocity to be constant. If this then be the case, we must come to but one conclusion. The greater the distance of any galaxy under consideration the greater must be the cumulative acceleration of its light corpuscles when they eventually reach the vicinity of our own (Milky Way) galaxy.

We shall now examine certain phases of the mechanics by means of which we may visualize conditions which might well produce the "red-shift," in the spectrum, and thereby account for the apparent phenomena of the "Expanding Universe," in a negative manner.

In the "Expanding Universe Theory," the "red-shift" is supposed to be produced by the lengthening of the light waves due to a rapid and ever-increasing rate of recession of the light source, brought about by the swift outward movement of the distant galaxies. Observations have also shown that the more distant the galaxy, the more rapid is its apparent recession from our own particular region

in space. The mechanics of this phenomenon might well be likened to the even and regular folds in the bellows of an accordion. These are lengthened as they are extended by the right arm of the player. Now the same apparent effect will be produced should the bellows be stretched in the opposite direction by the extension of the left arm.

Another good illustration of a negative interpretation is that of a whistle which is blown at a uniform pitch, the sound waves produced thereby radiating in every direction at constant frequency. Now if the whistle be stationary and we are rushing towards and past it at high speeds, as if on a swiftly moving train, we are overtaking the oncoming waves and thereby in effect increasing their frequency, shifting the pitch upward in the scale as we approach the whistle. The instant we pass the whistle the opposite or reverse phase of this phenomenon takes place, and as we recede from the whistle into the distance, the effective wave lengths are lengthened and the pitch accordingly drops. Now precisely the same effect may be obtained and observed if we ourselves remain stationary and the whistle approaches us, as if it were on a rapidly moving train, or the horn of an onrushing automobile; whereupon, the sound waves are also being overtaken and shortened by the moving source, and the pitch rises. Again, after passing, the reverse takes place and the pitch lowers as the whistle rapidly recedes in the distance.

In like manner, is it not rational to account for the phenomenon of the "red-shift" by an "Hypothesis of Accelerating Light Corpuscles," due to an immense forward pull acting upon them, produced by an enormous gravitational force such as that which must be possessed by our own galaxy? This, in effect, should result in a lessening of their frequency, if they be traveling through space regimented into wave motion; or, in augmenting their momentum and consequently their impact upon the optic nerve, if we choose to think of them as individualistic, unregimented particles. In either case the same "red-shift" in their spectrum would result and we would thus be able to explain an observed fact without being compelled to resort to the seemingly less tenable theory of the "Expanding Universe."

Obviously, the above brief statements do not cover nearly all of the factors involved. The problem is not so simple as this. However, to do so at the present time, even were it possible, would only becloud the issue, so we have given only this outline. We realize that we may have assumed some facts which cannot at present be substantiated, but who can predict what turn astronomical thought may take, and what new facts may be uncovered by future investigators?

It should be the problem of every person who ventures to state a new hypothesis to be able to suggest some method by means of which it may be either proven or disproven. Indeed, if this cannot be done his suggestion is scarcely worthy of the status of a hypothesis.

It so happens that our present problem has in it all of the essential elements for its own proof. In this we are fortunate. Our own Milky Way galaxy has been pictured as discoidal, not unlike the shape of a watch, the Solar System being off center, somewhat in the position of the second hand on the face of the watch, perhaps no larger in comparison, however, than the end of the minute axis upon which the second hand turns. In other words the location of the Solar System is in about one-fifth the diameter from one edge of the galaxy and about four-fifths from the opposite. Furthermore, the bodies of our own galaxy are evenly enough distributed that we may assume the center of its galactic gravitational mass to be somewhere near its physical center, which fact contributes to our solution.

Herein lies our possibility of proof. If our hypothesis be valid, then light corpuscles from outer galaxies coming to the earth by the long way through the galaxy should be accelerated more than those coming through the short way, or those coming at right angles to its longest axis. For our proof then, we have only to select galaxies of approximately equal distances in space, and apply this test. Should the spectrum of those whose light makes the long journey through our galaxy show a greater displacement towards the red than those whose light comes through the shortest distance, then our hypothesis is supported, if not, then we must seek another solution of the problem.

BEN HUR WILSON.

A Note on the Origin of Comets

That the solar system comprises two families, the planets and the comets, is a well-accepted view. This view is based on the differences between these two sets of bodies which no student of astronomy can fail to notice. A systematic study of the solar system will show that on the one hand there are the planets with their great masses, almost circular orbits in about the same plane, and satisfying the conditions of a long life of dynamically balanced condition of development. The comets, in contrast to these, are noted with their insignificant masses, eccentric orbits, closed and open varieties, in any plane, new ones being constantly discovered and old ones passing out. So, the recognition of the planetary and cometary families in the solar system is reasonable.

The theories of the solar system have been essentially those explaining the family of planets. Comets have to be explained separately. What is intended in this short article is to point out a view which either has not been mentioned in so many words or has not been given sufficient weight.

Stated in a few words, the idea is that comets can be explained as being constantly acquired by the solar system from interstellar matter and equally constantly being assimilated by the solar system.

At the rate comets change and disintegrate at present, during the life time alloted to the solar system of several billion years they would have vanished as comets long ago, if they originated at the time that the planets did. Bobrovnikoff's conclusion that the comets were acquired by the solar system some few million years ago, while the sun passed through a nebula, is possible. But if we have something more reasonable and probable that view should be preferred.

Acquisition of comets by the sun's passage through a nebula a million years ago offers no explanation to comets with open orbits, of which the non-existence has not been proven. Further, such a passage of the solar system through a nebula should have left on the system an effect that can be called catastrophic of a mild nature, besides acquiring comets.

It is known that the aggregation of matter in the galaxy is not confined to stars and nebulae. Atoms of matter at the rate of one atom per cubic inch, interstellar meteors, nebulae, bright or dark, and stars are recognized inhabitants of the universe. The continuity of nature makes it reasonable to suppose the existence of aggregations of matter similar in nature to diffuse nebulae but very small, such as cannot be seen by any method of observation, but in mass corresponding to cometary masses.

In this kind of space the sun is moving at the rate of twelve miles a second with its gravitational field spread around it like a fisherman's net. Combing the space in this manner, the sun would catch, now and then, matter that will be identified as a comet if it is large enough to make one. The radius of the solar system

is not greater than 40 astronomical units so far as the known planets are concerned. But the reach of the gravitational field of the sun goes much farther. In fact, it is limited by the fields of the neighboring stars. However, even if we allow a fairly large radius for the sun's gravitational field, the volume that the sun would sweep through in thousands of years will be exceedingly small compared to interstellar distances. And yet even such a small volume of space would be sufficient to account for the comets that are found in our system.

According to this idea all comets must have originated outside the solar system. Just as in the case of the fisherman, so in the case of the solar system, not every object intercepted will be retained. A good many will ecape the gravitational net. These, if they pass around the sun near enough to be seen, will constitute comets of parabolic orbits. But a number of these masses of matter will remain in the system due to a change in their orbits making them members of the solar system.

Comets so appropriated change constantly along known lines. Of course very large comets may take many hundreds of thousands of years before they are changed into something of a stabilized status. But small comets in short time will cease being comets. What becomes of them? They break into meteoric streams; they fall on planets as meteorites; they are (very few perhaps) added to the group of asteroids; and it is probable that some satellites may be accounted for in this manner. We shall use the word *assimilation* to denote the various processes by which comets eventually are lost as comets, leaving only their insignificant mass as an addition to the solar system.

G. K. DAGHLIAN.

Connecticut College, New London, Connecticut.

Cosmology and Newton's Theory

When a theory is advanced with the statement that it is comprehensible to only a few persons—a theory involving factors which are themselves theories not well established—it may be interesting to consider the method of deduction offered by the proponents of Relativity, in relation to very simple matters that are concomitant and germane to the subject, and that are comprehensible to everyone.

Regarding the universe, as a whole, surely the most natural conclusion is that, however far we might travel through space, we should find everywhere an attenuated swarm of fixed stars of approximately the same kind and density.

But this view, Professor Einstein states, is not in harmony with the theory of Newton; that the latter theory rather requires that the universe should have a kind of center where the density of stars is a maximum, and diminishing, as we proceed outward, until all is finally surrounded by empty space. For this conception Professor Einstein offers the following:

> "Proof: According to the theory of Newton, the number of 'lines of force' which come from infinity and terminate in a mass M is proportional to the mass M. If, on the average, the mass density ρ_0 is constant throughout the Universe, then a sphere of volume V will enclose the average mass $\rho_0 V$. Thus the number of lines of force passing through the F of the sphere into its interior is proportional to $\rho_0 V$. For unit area of the surface of the sphere the number of lines of force which enter the sphere is thus proportional to $\rho_0 V/F$, or to $\rho_0 R$. Hence, the intensity of the field at the surface would *ultimately* become infinite with increasing radius R of the sphere, which is impossible."

Of course, the masses here would increase as the cube, while the surface areas increase only as the square of the radius.

Based on this "proof," modifications of Newton's law have been formulated

in which, at great distances, the attraction between masses diminishes more rapidly than would result from the law of inverse squares, thus supposedly providing for an infinite universe of constant mass density.

Is this sound reasoning?

Let us make a perfect, ideal infinite universe of constant mass density by dividing it into imaginary equal cubes, and placing a star of unit mass at the center of each cube.

Then in this symmetrical universe apply Newton's law of gravity or *any other law* and no star would move. All forces would be balanced everywhere, and clearly at the surface of any imaginary sphere.

In such an ideal universe, just where would Professor Einstein locate his accumulated infinite force?

In an infinite universe of constant mass density the outward attraction at the surface of any imaginary sphere would exactly equal the attraction towards its center, clearly showing that the expanding sphere used in the "proof" was treated as though surrounded by empty space, overlooking the stipulation of constant mass density. Half-way between our sun and Sirius there are no lines of force in our direction. Theoretically, of course, there would be, but they are more than overcome by forces in the other direction.

The most surprising phase of this "proof," however, is the obvious failure to realize that, as the center of the expanding sphere could be shifted to any and every point in the universe, the supposed "intensity at the surface" would not "ultimately become" infinite, but the result would be *infinite force at every conceivable point in the universe.*

It can not be doubted, that, had not this latter fact been "overlooked," the attempt to modify Newton's law by such an argument, would have been abandoned.

It is stated that the law of Newton is not founded on any general theoretical principle. Whatever Sir Isaac himself may have thought about that, it is undeniable that Newton's law *agrees* precisely with the simplest, clearest and most impregnable theoretical principle that it is possible to imagine, and that is, "The wider you spread your butter, the thinner it gets." As the "spreading" of light, gravity, heat, sound, etc., is necessarily spherical, the law of inverse squares for the intensity is inevitable and unalterable. Let the thickness of the film of a rubber balloon represent the intensity of gravity. Blow the balloon up from one foot to three feet diameter, and the film's thickness is necessarily decreased to one-ninth its former state.

It is to be hoped that when the amount of deflection of star light passing the sun is finally determined, some more satisfactory *cause* for it will be found than that of *one-half* gravity and *one-half* "space curvature caused by the sun." If the cause should finally be found to be a *refraction* by the sun's corona, which is little understood, it would clear up many things.

DAVID FLEMING.

General Notes

Professor H. H. Nininger, Director of the Nininger Laboratory, Curator of Meteorites in the Colorado Museum of Natural History, Denver, and Secretary-Treasurer of the Society for Research on Meteorites, was awarded the honorary degree of Doctor of Science at the fiftieth annual commencement exercises of McPherson College, McPherson, Kansas, on May 31, 1937, in recognition of his work in the field of meteoritics.

Dr. J. S. Plaskett, C.B.E., F.R.S., formerly Director of the Dominion Astrophysical Observatory, Victoria, B. C., recently spent three weeks in Cleveland. There, in his capacity as scientific consultant of The Warner & Swasey Company, famous as builders of many of the world's great telescopes, he has been observing progress and consulting on methods in the figuring of the 82-inch mirror for the McDonald Observatory in Texas. The 60-inch flat, required in the final tests is completed and the parabolizing of the 82-inch mirror is proceeding satisfactorily with the probability of completion at a relatively early date.

American Astronomical Society Meeting.—The fall meeting of the American Astronomical Society will be held this year on September 8 to 11 at Williams College, Williamstown, Massachusetts. Detailed information concerning the plans for the meeting may be obtained from Professor Willis I. Milham, Williamstown, Massachusetts. A report of this meeting will appear in the October issue of POPULAR ASTRONOMY.

Greenwich Observatory.—The report of the Astronomer Royal to the Board of Visitors of the Royal Observatory at Greenwich has been issued in a quarto brochure of thirty-eight pages, having been read at the annual visitation on June 5, 1937. It covers the work of the Observatory for the year ending April 30, 1937.

A reading of this report gives one a clear idea of the varied and extensive forms of work in progress at this well-known astronomical center.

The Nantucket Maria Mitchell Association has issued its 35th annual report in a pamphlet of 54 pages. Nearly one-half of this report is devoted to the astronomical work of this Association. It contains an excellent photograph of Peltier's Comet taken in a dense stellar region in the Milky Way on July 22, 1936. In addition to the astronomical section there are reports from various officers, and other departments, and also a complete list of members, past and present.

NBC Eclipse Announcer Builds Himself Umbrella Planetarium

If you're in doubt about the relative positions of the North Star and Vega, get yourself an old umbrella and make a planetarium, George Hicks, NBC announcer, advised before he began a 7,000-mile journey to the South Seas, where, on June 8, he described the longest total eclipse of the sun in 1,200 years.

Hicks thought he should know something about astronomy, since he was assigned to the job of announcing the many programs NBC broadcast in connection with the National Geographic Society's solar eclipse expedition. So, in talking with Col. Oscar Fogg, vice-president of the Consolidated Edison Company of New York, and an amateur astronomer of the first rank, he discovered a simple method for learning the lay-out of the heavens. That is where the umbrella comes in.

The inner surface of an umbrella, he found, makes an excellent model of the sky. Upon it Hicks drew the major stars and constellations: the North Star, Vega, Cassiopeia, Capella, and the Dipper. Having them all in their proper positions, he dropped the edge of his model over a table edge, representing the horizon. Rotation of the umbrella takes the place of the earth's rotation. By comparing textbooks on astronomy with his planetarium and this, in turn, with the heavens themselves, Hicks found he was able to fix firmly in mind the position of most of the important stars and constellations.

Before he left on the long journey that reached its climax in the fifteen-minute broadcast of the total eclipse June 8, Hicks could speak with some authority on,

and do a little pointing at, the starlit heavens of Manhattan. He enthusiastically recommends the umbrella planetarium to everybody interested.

An Auroral Display

The display was witnessed on the morning of June 6, 1937. It was quite bright even when first noticed about 1:00 A.M., C.S.T., and was in the form of a low arch in the north. From 1:20 to 1:50 A.M., the arch spread, faint streamers developed, and waves of light passed through the glow. One darker spot was seen in the glow for a time. After 2:00 the display began to fade and was gone by 3:00 A.M.

HUGH M. JOHNSON.

3207 Cornell Street, Des Moines, Iowa.

Book Reviews

Amateur Telescope Making—Advanced, Edited by Albert G. Ingalls. (Munn and Co., Inc., New York City. $3.00 domestic, $3.35 foreign, postpaid.)

The volume bearing the above title is a sequel to "Amateur Telescope Making," the book that inspired many thousands to try their hand as opticians and telescope makers. Naturally from these workers there are a number who have become most proficient, equalling and in some cases surpassing the trained professional. The wealth of material they have contributed has been incorporated by Albert H. Ingalls, Associate Editor of *Scientific American,* into a book of two parts. The first contains many chapters on grinding and polishing technique, new testing methods for mirrors and objectives, detailed instructions for the figuring of plane and aspheric surfaces of various forms, etc. The more recent developments in optical instruments used in the advance of astronomy, such as the Schmidt-camera, are well covered. The discussions of various methods of testing lenses both qualitatively and quantitatively are most instructive. Many other items of the highest practical value to both amateur and professional are included.

Part II of the book is devoted to the study of the practical aspects of observational astronomy such as meteor and eclipse photography, a rather complete study of the atmospheric effects in telescopic observation, and a lucid discussion of the time-worn controversy of reflectors versus refractors.

This book should be included in the libraries of all educational institutions and individuals using optical instruments.

R. S. PERKIN.

A Manual of the Principles of Meteorology, by R. Mountford Deeley. (Charles Griffin and Company, Ltd., 42 Drury Lane, London. 15 shillings.)

The above is the title of an attractively bound book, issued in 1935. Not only is the book well bound but it contains a large amount of valuable information as well. The realm of facts and theories with which this volume deals is not so frequently treated as some others of the natural sciences, and therefore a new work in this field is a valuable contribution to the literature which is pertinent. The volume contains a frontispiece, showing an unusual aurora phenomenon, and 134 other illustrations and 27 tables. It comprises 281 pages, divided into fourteen chapters, an appendix, and an index.

The chapters deal with the atmosphere and the changes of temperature and

pressure constantly occurring in it. The last three chapters are concerned with the influence of sunspots, the long range changes in climate, and the Quaternary Ice Age. In reading the book one receives the definite impression that the author is thoroughly conversant with the materials he is using, and is, therefore, to be regarded as an authority in his field.

Since the weather is of perennial interest to everyone, a book of this kind has a large and important place to fill.

Kleine Meteoritenkunde, by Fritz Heide. (Published by Julius Springer, Linkstrasse 23-24, Berlin. 4.80 marks.)

This booklet of 120 pages is the twenty-third in a series dealing with various phases of science in a simplified and easily comprehensible form. The author is professor of mineralogy and petrography at the University of Jena.

The work is divided into three distinct chapters and a supplement. The first chapter deals with the phenomena accompanying the fall of a meteor or meteorite; the second, with the material composition of the meteorite; and the third, with the origin and significance of meteorites.

The presentation is clear and authoritative, there are numerous tabulations containing information in a condensed and convenient form, the paper used is of good quality and shows very well the many types of meteorites and terrain with which the discussion has to do. The pages devoted to the supposed large Siberian fall in 1908 and to the recently noticed "Carolina Bays" afford interesting reading. As already intimated the 92 charts and photographic reproductions contribute greatly to the value of this volume. The concluding pages contain some remarks on the *tektites* for which there is not yet a satisfactory theory.

This neat, scientifically accurate and intelligible work is to be highly recommended to those persons for whom the study of meteors is an interesting avocation.

Norton's Star Atlas.—(Messrs. Gall and Inglis, 12 Newington Road, Edinburgh, 9; Eastern Science Supply Co., P. O. Box 1414, Boston, Massachusetts. Price $5.00 postpaid in U.S.).

The first edition of this useful volume was published in 1910, and new editions of it have appeared from time to time until now a copy of the sixth edition is at hand. We note from the preface to the sixth edition that "In this sixth edition, the charts now give longitude along the ecliptic, and the principal novae have been inserted to date. In the Handbook, most of the earlier letterpress has been rewritten and extended, and the remainder revised. A Sunset Table for various latitudes, the meanings and pronunciation of constellation names, and several Tables convenient for reference purposes have been added—also, in the 'Use of the Telescope' section, additional notes on mirrors and various kinds of eyepieces."

Indicative of the expansion in the successive editions is the fact that, while in the third edition the index of contents covers one page, in the sixth edition it covers nearly two. It is impossible to begin to list the topics presented in this volume, for they cover practically the complete field of astronomy. In this, and in the fifth edition as well, the constellation boundaries are drawn in accordance with the International Astronomical Union's scheme. On the charts the general outline of the Milky Way is delineated.

A new feature in this edition is the offer of the publishers to supply an extra set of the star maps, 1-17, for the sum of 7 shillings, 6 pence, to be used as a work-

ing copy. To receive this special price it is necessary to use the coupons which are bound in the copies of the sixth edition.

This work can be highly recommended as a volume of useful, convenient, and pertinent information in astronomy.

Publications of the Observatory of Michigan, Volume VI, No. 12, recently received, contains a detailed history, by Dr. Dean B. McLaughlin, of the spectrum of Nova Herculis. It consists of 107 lithographed pages, quarto size, and four pages of photographs of the spectrum at various dates. Volume VII, No. 1, published early this year, is devoted to a description of the Tower telescope of the McMath-Hulbert Observatory of the University of Michigan. Fifty-six pages, quarto size, are devoted to a description of this unique observatory and its equipment. In addition there is a double page plate of the 50-foot Tower telescope, and nineteen full page plates showing various pieces of equipment in great detail. One of the features of the work at this observatory is the making of motion pictures of changes on the sun. The final plate shows an illustration of this rather new investigation.

Publications of the David Dunlap Observatory, University of Toronto, Volume I, No. 1.

The initial number of a series of publications deserves especial attention. This is particularly true of a series emanating from an institution so well equipped for its purpose as is the David Dunlap Observatory and, consequently, destined to contain reports of important researches in the years to come.

The number at hand is of convenient size and contains 56 pages. It is devoted entirely to a description of the Buildings and Equipment of the David Dunlap Observatory. There are 24 full-page plates and also other figures and diagrams. The descriptive material is concerned with the technicalities of the equipment.

Greetings and good wishes are hereby expressed by a publication which has attained the age of forty-five to one which has just taken its first step.

Publications Received.—The publishers of POPULAR ASTRONOMY hereby acknowledge the receipt of the following named publications and express their great appreciation of the courtesy shown on the part of those who have sent them.

Contributions from the Mount Wilson Observatory:

No. 554. An Improved Method of Determining Absolute-Magnitude Distributions, with Application to the Early K Stars, by Gustaf Strömberg.
No. 555. Intensities of Blended Absorption Lines, by A. D. Thackeray.
No. 556. A Spectroscopic Examination of Meteorites, by Arthur S. King.
No. 557. Effects of Red Shifts on the Distribution of Nebulae, by Edwin Hubble.
No. 558. Computation of Mean Parallaxes, Mean Absolute Magnitudes, and Mean Distances for Groups of Stars from Components of the Proper Motions, by Gustaf Strömberg.
No. 559. Spectroscopic Observations of V Canum Venaticorum, by Alfred H. Joy and Paul W. Merrill.
No. 560. Revised Spectral Types of a Group of Stars in Kapteyn Area 98, by Milton L. Humason.
No. 561. Note on the Motion of Masses of Gas near Novae, by R. Minkowski.

Contributions from the McDonald Observatory, Fort Davis, Texas.—Numbers 2 and 3 of this new series of observatory publications have been issued as reprints from the *Astrophysical Journal.* The former is a study of "Reflection Nebulae" by Otto Struve, C. T. Elvey, and F. E. Roach. The latter is entitled: "A Photoelectric Study of the Light from the Night Sky" by C. T. Elvey and F. E. Roach, and a "Note on Interstellar Scattering" by L. G. Henyey. Number 1 of this series is to contain a biography of Mr. McDonald, the donor of the funds for this observatory, and will be issued later.

Because of the exceptional equipment and unusually favorable location of this Observatory, this series just begun will doubtless grow in importance in the coming years. POPULAR ASTRONOMY extends congratulations upon this auspicious beginning.

Lick Observatory Bulletin, No. 484, recently issued, is devoted to the results of work done by Clifford E. Smith in partial fulfillment for the degree of Doctor of Philosophy in the University of California. The subject of this dissertation is: "An Investigation of Selective Absorption in the Aquila Region of the Milky Way."

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SUBSCRIPTION PRICE.—The price of Popular Astronomy to subscribers living in the United States, or in a country to which the special rate of postage is applicable, is $4.00 per volume, of ten numbers; in Canada, $4.25; to all others, $4.50; in each case payable strictly in advance. Checks or Postal Money Orders should be made payable to Popular Astronomy.

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REPRINTS of articles, when desired, will be furnished to authors at the actual cost involved. Those wanting reprints should order them when the manuscript is sent to the editor. They cannot be furnished later without incurring much greater expense.

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